Profile of metacognition of mathematics education students in understanding the concept of integral in category inferring with regard gender differences

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Abstract. The purpose of this study was to produce a metacognition profile of female and male mathematics education students in understanding the integral concepts in the Inferring category. A metacognition profile is a natural and intact description of one's cognition that involves his own thinking in terms of using his knowledge, planning and monitoring his thinking processes, and evaluating the results of his thinking when understanding concepts. This research method is an exploratory method with a qualitative approach. The research subjects were mathematics education students, consisting of 1 female and 1 male who had studied integral calculus. The main data collection of this study was obtained using interview techniques. The results of this study are as follows there is no difference in the metacognition profile between male and female mathematics education students in understanding the concept of indeterminate integral in the Inferring category.

1. Introduction
Understanding is the second category of cognitive processes according to Bloom's Taxonomy. When the purpose of teaching is to promote retention, the most important cognitive process is Memory. However, if the aim of the teaching is to promote transfer, the focus shifts to five other categories of cognitive processes, namely understanding, implementing, analyzing, evaluating, and creating. And the most dominant transfer to educational goals emphasized in school and in college is Understanding.

Mayer said that students can understand when they establish a connection between new knowledge they can get with prior knowledge [1]. More specifically, incoming knowledge is integrated with existing cognitive schemes and frameworks. Cognitive processes in the understanding category consist of 7 components, namely: Interpreting, Exemplify, Classifying, Summarizing, Inferring, Comparing, and Explaining [1, 2]. In this study, the understanding category is seen from the Inferring category. And the definition of Inferring is taking logical conclusions from the information presented [3].

The metacognition profile is a natural and intact description of a person's cognition that involves his own thinking in terms of his or her knowledge, and the ability to plan and monitor his thinking process, and evaluate the process and outcome of one's thinking when understanding a concept. The metacognition profile in comprehending the integral concept is reviewed in two categories: metacognitive knowledge consists of declarative knowledge, procedural knowledge, and conditional knowledge [4, 5], and metacognition skills comprising planning, monitoring and evaluating [6-8].
Metacognition profiles are distinguished between male and female students. Thus, this research question is for the profile of metacognition of female and male mathematics education students in understanding the integral concepts in the Inferring category.

2. Method
This research method is explorative method with qualitative approach. This explorative research is intended to explore the metacognition of students of mathematics education of male and female in understanding the concept of integral calculus so as to obtain a large profile of student’s metacognition. The subject of the study (RS) is a Mathematics Education student studying the integral calculus, consisting of 1 male and 1 female. Selection of this study subjects based on the highest score of the Mathematics Ability Test (score > 70), and consider the value of student achievement. The main data of this research is obtained by interview technique. In addition, there are supporting data which is the result of the paper of research subject in comprehending integral calculus task. The data analysis process follows the analysis model of Miles and Huberman [3], consisting of: (1) data reduction, data presentation, and (3) conclusion. Interpretation of data carried out simultaneously with data presentation activities. In this activity, researchers do interpretation of research data (answers RS at the time of interview). Making conclusions and recommendations based on the results of data processing to answer research questions, namely finding the profile of students' metacognition in understanding the concept of integral calculus.

3. Results and Discussion
The results of this study reveal the metacognition profile of male and female mathematics education students in understanding the concept of integral calculus, the Inferring category through interviews. The results of the interview can be stated as follows.

3.1. The results of male student interviews about understanding the concept of integral calculus in the Inferring category
The results of male students' interviews about understanding the concept of integral calculus in the Inferring category consist of the concepts of indefinite integrals and definite integrals:

3.1.1. The Indefinite Integral Concepts. The results of male student interviews in understanding the concept of indefinite integrals in the Inferring category according to student metacognition that is declarative knowledge, Procedural knowledge, Conditional knowledge, Planning, Monitoring, and Evaluating as follows: (1) Conscious male mathematics education students can mention and write conclusions from several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \quad \int (5x - 4)^2 \, dx = \frac{1}{(5)(3)} (5x - 4)^3 + C, \) and \( \int (-2x + 5)^2 \, dx = \frac{1}{(-2)(3)} (-2x + 5)^3 + C, \) that is the integral of \((ax + b)^2 \, dx\) is \(1/(3a)\) multiplied \((ax + b)^3\) plus \(C,\) (2) Conscious male mathematics education students can mention procedures to conclude from several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \quad \int (5x - 4)^2 \, dx = \frac{1}{(5)(3)} (5x - 4)^3 + C, \) and \( \int (-2x + 5)^2 \, dx = \frac{1}{(-2)(3)} (-2x + 5)^3 + C \) that is, the integral of \((ax + b)^2 \, dx\) is \(1/(3a)\) multiplied \((ax + b)^3\) plus \(C\) based on the pattern, (3) Male mathematics education students are aware of the procedure for concluding from several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \quad \int (5x - 4)^2 \, dx = \frac{1}{(5)(3)} (5x - 4)^3 + C, \) and \( \int (-2x + 5)^2 \, dx = \frac{1}{(-2)(3)} (-2x + 5)^3 + C \) is based on patterns. And the subject of male mathematics education students is also aware that there are still other strategies to determine conclusions that are based on indeterminate integral rules but find it difficult to show them, (4) Students aware of male mathematics education can provide strategies when...
concluding from several statements: \[ \int (4x)^2 \, dx = \frac{1}{4} (4x)^3 + C, \quad \int (5x-4)^3 \, dx = \frac{1}{5} (5x-4)^4 + C, \quad \text{and} \]
\[ \int (-2x+5)^3 \, dx = \frac{1}{(-2)(3)} (-2x+5)^4 + C \]
being an integral of \((ax + b)^2\) \(dx\) is \((3a)\) multiplied \((ax + b)^3\) plus \(C\), based on the pattern, (5) Male mathematics education students can control the results of conclusions from several statements: \[ \int (4x)^2 \, dx = \frac{1}{4} (4x)^3 + C, \quad \int (5x-4)^3 \, dx = \frac{1}{5} (5x-4)^4 + C, \quad \text{and} \]
\[ \int (-2x+5)^3 \, dx = \frac{1}{(-2)(3)} (-2x+5)^4 + C \]
that is, the integrals of \((ax + b)^2\) \(dx\) is \((3a)\) multiplied \((ax + b)^3\) plus \(C\), that is by examining the results of the conclusions is correct, although it still feels difficult to determine the \(x\) coefficient that is \(a\) of the three statements so the results are \(1/a\), and (6) Students of conscious male mathematics education can mention the results of the conclusions of several statements:

\[ \int (4x)^2 \, dx = \frac{1}{4} (4x)^3 + C, \quad \int (5x-4)^3 \, dx = \frac{1}{5} (5x-4)^4 + C, \quad \text{and} \]
\[ \int (-2x+5)^3 \, dx = \frac{1}{(-2)(3)} (-2x+5)^4 + C \]
that is, the integral of \((ax + b)^2\) \(dx\) is \((3a)\) multiplied \((ax + b)^3\) plus \(C\).

Based on the interview results of the male students, it was revealed that male students had used metacognition knowledge and metacognition skills in understanding the concept of indefinite integrals in the Inferring category.

3.1.2. The Definite Integral Concepts. The results of male student interviews in understanding the concept of definite integrals in the Inferring category as follows: (1) Conscious male mathematics education students can mention and write conclusions from several statements: \[ \int [x] \, dx = 1(2-1)=1 \]
, \[ \int^3_2 [x] \, dx = 2(3-2)=2 \]
and \[ \int^5_3 [x] \, dx = 3(4-3)=3 \]
is \[ \int^{n+1}_n [x] \, dx = n(n+1-n)=n(1)=n \]
; (2) Male mathematics education students can mention the procedure for concluding from several statements: \[ \int^5_3 [x] \, dx = 1(2-1)=1 \]
, \[ \int^4_2 [x] \, dx = 2(3-2)=2 \]
and \[ \int^4_3 [x] \, dx = 3(4-3)=3 \]
is \[ \int^{n+1}_n [x] \, dx = n(n+1-n)=n(1)=n \]
based on the pattern, (3) Male mathematics education students can only provide reasons for the conclusion of the statement \[ \int^{n+1}_n [x] \, dx = n(n+1-n)=n(1)=n \]
based on patterns only. In fact, there are still other reasons for using indeterminate integral rules, but the subject of male mathematics education students find it difficult to use these rules, (4) Male mathematics education students can provide strategies when concluding from several statements: \[ \int^3_2 [x] \, dx = 1(2-1)=1 \]
, \[ \int^3_2 [x] \, dx = 2(3-2)=2 \]
and \[ \int^4_3 [x] \, dx = 3(4-3)=3 \]
is \[ \int^{n+1}_n [x] \, dx = n(n+1-n)=n(1)=n \]
based on the pattern, which is for the second statement \[ \int^4_3 [x] \, dx = 2(3-2)=2 \], means that the integral result is equal to the lower limit of the integral, which is 2. Similarly for the third statement \[ \int^4_3 [x] \, dx = 3(4-3)=3 \], means that the integral result is equal to the lower limit of the integral, which is 3, (5) Male mathematics education students can control the results of conclusions from several statements: \[ \int^1_0 [x] \, dx = 1(2-1)=1 \]
, \[ \int^1_0 [x] \, dx = 2(3-2)=2 \]
and \( \int_0^1 x \, dx = 3(4-3) = 3 \), is \( \int_0^{n+1} x \, dx = n(n+1-n) = n(n) = n \), that is, by examining the results of the conclusions it is correct, although it is still difficult to determine the integrals using the basic calculus theorem, and (6) Male mathematics education students can mention the results of the conclusions of several statements: \( \int_0^2 x \, dx = 1(2-1) = 1 \), \( \int_0^2 x \, dx = 2(3-2) = 2 \) and \( \int_0^2 x \, dx = 3(4-3) = 3 \), that is \( \int_0^{n+1} x \, dx = n(n+1-n) = n(n) = n \). And the subject of male mathematics education students found it difficult to deduce the integral of \( \int_0^{n+1} x \, dx = n(n+1-n) = n(n) = n \) based on the basic calculus theorem.

Based on the interview results of the male students, it was revealed that male students had used metacognition knowledge and metacognition skills in understanding the concept of definite integrals in the Inferring category.

### 3.2. Results of female student interviews about understanding the concept of integral calculus on the Inferring category

Results of female student interviews about understanding the concept of integral calculus on the category of Inferring consists of the concept of indefinite integrals and definite integrals:

#### 3.2.1. The Indefinite Integral Concepts

The results of female student interviews in understanding the concept of indefinite integrals in the Inferring category as follows: (1) Female mathematics education students can mention and write conclusions from several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \)

\( \int (5x-4)^2 \, dx = \frac{1}{(5)(3)} (5x-4)^3 + C \), and \( \int (-2x+5)^2 \, dx = \frac{1}{(-2)(3)} (-2x+5)^3 + C \), is \( 1/(a(2+1)) \) multiplied \((ax + b)^{2+1}\) plus \( C \) or \( 1/(3a) \) multiplied \((ax + b)^3\) plus \( C \); (2) Female mathematics education students can state the reasons for concluding from several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \)

\( \int (5x-4)^2 \, dx = \frac{1}{(5)(3)} (5x-4)^3 + C, \) and \( \int (-2x+5)^2 \, dx = \frac{1}{(-2)(3)} (-2x+5)^3 + C \) is based on the pattern, that is, \( a \) is obtained from the coefficient \( x \) in the function \((ax + b)^2\), and \((1/3)(ax + b)^3\) is obtained from the nature of the indefinite integral; (3) Students of female mathematics education can provide other reasons for the conclusions of some of these statements, namely using the nature of indefinite integrals but the difficulty to prove them; (4) Female mathematics education students can determine procedures to conclude from several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \)

\( \int (5x-4)^2 \, dx = \frac{1}{(5)(3)} (5x-4)^3 + C, \) and \( \int (-2x+5)^2 \, dx = \frac{1}{(-2)(3)} (-2x+5)^3 + C \) is based on the pattern, that is for the first statement: from function \((4x)^2\) then \( a = 4 \), second statement: from function \((5x-4)^2\) then \( a = 5 \), third statement: from function \((-2x+5)^2\) then \( a = -2 \). Because each function of the statement is of the second rank based on the indeterminate integral properties obtained \((1/3)(ax + b)^3\), (5) Female mathematics education students can control the results of conclusions from several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \)

\( \int (5x-4)^2 \, dx = \frac{1}{(5)(3)} (5x-4)^3 + C, \) and \( \int (-2x+5)^2 \, dx = \frac{1}{(-2)(3)} (-2x+5)^3 + C \), that is, based on the pattern is correct, and if based on the nature of the indeterminate integral, it cannot prove it, and (6) Students of conscious female mathematics education can mention the results of the conclusions of several statements: \( \int (4x)^2 \, dx = \frac{1}{(4)(3)} x^3 + C, \)

\( \int (5x-4)^2 \, dx = \frac{1}{(5)(3)} (5x-4)^3 + C, \) and
\[
\int (-2x+5)^2 \, dx = \frac{1}{(-2)(3)} (-2x+5)^3 + C
\]
that is, the integrals of \((ax + b)^3 \, dx\) are \(1/(3a)\) multiplied \((ax + b)^3\) plus \(C\). And it is not difficult to deduce the integral of \((ax + b)^3 \, dx\) are \(1/(3a)\) multiplied \((ax + b)^3\) is added by \(C\) based on the pattern, and the difficulty is based on the indeterminate integral properties.

Based on the interview result of female students, the female students have used metacognition knowledge and metacognition skills in understanding the concept of indeterminate integrals in the Inferring category.

3.2.2. The Definite Integral Concepts. The results of female student interviews in understanding the concept of definite integrals in the classifying category as follows: (1) Female mathematics education students can mention and write conclusions from several statements: \(\int [x] \, dx = 1(2-1)=1\), \(\int [x] \, dx = 2(3-2)=2\) and \(\int [x] \, dx = 3(4-3)=3\), is \(\int_{n}^{n+1} [x] \, dx = n(n+1-n)=n\); (2) Female mathematics education students can mention the procedure for concluding from several statements: \(\int [x] \, dx = 1(2-1)=1\), \(\int [x] \, dx = 2(3-2)=2\) and \(\int [x] \, dx = 3(4-3)=3\), is \(\int_{n}^{n+1} [x] \, dx = n(n+1-n)=n\) based on the pattern; (3) Female mathematics education students can only provide reasons for the conclusion of the statement \(\int_{n}^{n+1} [x] \, dx = n(n+1-n)=n\) based on patterns only. In fact, there are still other reasons for using indeterminate integral rules, but the subject of female mathematics education students find it difficult to use these rules; (4) Students of female mathematics education can provide strategies when concluding from several statements: \(\int [x] \, dx = 1(2-1)=1\), \(\int [x] \, dx = 2(3-2)=2\) and \(\int [x] \, dx = 3(4-3)=3\), is \(\int_{n}^{n+1} [x] \, dx = n(n+1-n)=n\) based on the pattern, which is for the first statement: \(\int [x] \, dx = 1(2-1)=1\), means that the integral result is equal to the lower limit of the integral, namely 1. The second statement: \(\int [x] \, dx = 2(3-2)=2\), means that the integral result is equal to the lower limit of the integral, which is 2. Similarly for the third statement: \(\int [x] \, dx = 3(4-3)=3\), means that the integral result is equal to the lower limit of the integral, which is 3; (5) Female mathematics education students can control the results of conclusions from several statements: \(\int [x] \, dx = 1(2-1)=1\), \(\int [x] \, dx = 2(3-2)=2\) and \(\int [x] \, dx = 3(4-3)=3\), is \(\int_{n}^{n+1} [x] \, dx = n(n+1-n)=n\), that is, by examining the results of the conclusions it is correct, although it is still difficult to determine the integrals using the basic calculus theorem; and (6) Female mathematics education students can mention the results of the conclusions of several statements: \(\int [x] \, dx = 1(2-1)=1\), \(\int [x] \, dx = 2(3-2)=2\) and \(\int [x] \, dx = 3(4-3)=3\), that is \(\int_{n}^{n+1} [x] \, dx = n(n+1-n)=n\). And the subject of female mathematics education students found it difficult to deduce the integral of \(\int_{n}^{n+1} [x] \, dx = n(n+1-n)=n\) based on the basic calculus theorem.

Female mathematics education students can mention the procedure for concluding from several statements:
Based on the interview result of female students, the female students have used metacognition knowledge and metacognition skills in understanding the concept of definite integrals in the Inferring category.

The results above show that there is no difference in the metacognition profile between male and female students in understanding the concept of integral calculus in the Inferring category, both indeterminate and definite integral concepts. This is in accordance with previous research in the interpreting category that there is no difference in the metacognition profile between male and female students in understanding the concept of integral calculus in the Interpreting category, especially the concept of indeterminate integrals [9]. Similarly, the results of Sullivan's study [10] concerning student achievement and not finding gender differences in mathematics achievement. Then, Sarouphim & Chartouny [11] also reported no significant gender differences in mathematics achievement. However, they are still weak in mastering the concept of integral calculus, both the concept of indefinite integrals and definite integrals, because in concluding a statement it is not the only use of patterns but can use properties and theorems in integral calculus. In addition, in applying the theorem for certain cases students do not pay attention to conditions that fulfill the rules of the theorem. This shows that the students' knowledge of mathematics education about integral calculus especially the definite integral concepts on the Inferring category are still low.

The results of this study yielded several findings. Students Mathematics education in the early semester has not mastered the basic concepts of mathematics, especially related to the concept of integral. Such as the concept of a complex function, such as the function of absolute value, integer function, logarithm function, and exponential function. Similarly, students have not been able to draw a function. This has an impact on the process of metacognition of students in completing the task of mathematics, especially integral calculus. Students have not been able to give a reason or explanation about the results of his work primarily on a rather difficult problem. Based on these findings, it is suggested to researchers and teachers of mathematics education that in teaching the concept of mathematics starting from the basic concepts then developed on difficult concepts. Furthermore, the Learning process tries to implement the strategies developed by Panaoura [12] and Kelly [13]. With the learning strategy, it is expected to train student’s metacognition in completing math tasks. To assess students’ metacognition control, they are asked to voice their thoughts (think aloud) about what to do and think about in solving problems.

4. Conclusion
Based on the results of the research and discussion above, it can be concluded that: there is no difference in the metacognition profile between male and female students in understanding the concept of integral calculus both indeterminate and integral integral concepts of course, especially the Inferring category. In addition, male and female students in concluding a certain statement only see the pattern, but can also use the properties and theorems in integral calculus.

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