Analysis of mathematical ability based on gender

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Abstract. The purpose of the study was to analyze the mathematical abilities of students of mathematics education regarding gender and personality. Mathematical abilities include the ability to explore, speculate and logical reasons for solving routine and non-routine problems. While gender is a cultural concept that is used to identify differences regarding roles, behaviours and others between male and female that develop in a society based on social engineering. This study is descriptive research. The subjects of this study were 38 students of mathematics education department of Universitas Halu Oleo, consisting of ten male and 28 female. Based on gender tests, it will be classified into four types: masculine male, feminist male, masculine female, and feminine female. Based on the results of the analysis through a mathematical ability test, it can be concluded that there are differences in mathematical abilities based on gender.

1. Introduction
In general, there are more women than men enrolled in the mathematics education department. This fact can be seen from the data on the number of students entering the Department of Mathematics Education at Halu Oleo University for class A in 2016 totalling 47 students, consisting of 12 men and 35 women. While the 2018 class numbered 65 students, consisting of 15 men and 50 women. This data illustrates that women's interest and motivation in mathematics are higher than that of men. Will this student's interest and motivation affect their mathematical abilities?

There are several results of previous studies looking at gender differences. Some argue that girls' learning motivation was higher than boys, but did not show differences in learning achievement and self-efficacy [1]. Then, the other study believes that boys got scores of self-success verbal problems higher than girls, but did not differ in scores on self-efficacy of mathematical problems [2]. Furthermore, when viewed from the level of intelligence, smart women show a high level of intelligence and academic achievement than smart boys, but less intelligent women can display lower expectations than men [3]. When viewed from the metacognition of students of mathematics education in understanding the concept of integral calculus regarding gender differences, it appears that there are differences in the metacognitive profile of male and female students. And female students have used metacognitive knowledge and skills in understanding the concept of integral calculus of course, while male students only use declarative knowledge [4].

Gender in this study is also interpreted as differences in the male and female gender, also seen from differences in gender roles. Gender identity is defined as a personal concept of oneself as male or female [5]. This concept is closely related to the concept of gender roles, which are defined as manifestations outside of personality that reflect gender identity. Then, gender roles consist of masculine, feminine, androgynous, and undifferentiated [6]. The masculine characteristics are athletic, independent, analytical, competitive, and aggressive, while the feminine features such as love, are sensitive to the
needs of others, compassion, soft-spoken, and warm [7]. While androgyny features have two personalities, namely masculine characteristics and feminine features. Later, the stereotypical masculine and feminine characteristics were not bound to biological sex. The majority of girls at the age of 12 to 13 years old can be found in the androgyny category, i.e. they tend to have highly developed masculine and feminine characteristics [8]. On the other hand, the majority of boys show characteristics that are indistinguishable, that is, they have low masculine and feminine characteristics. Our longitudinal study will provide evidence of how gender identity changes over time.

The review of mathematical abilities based on gender in this study was viewed from differences in the male and female sex, and differences in gender roles namely masculine men, feminine men, feminine women and masculine women. Thus, this study focus to present the mathematical abilities of mathematics education students regarding their gender differences and personality differences. Moreover, this study also discusses to what extent the mastery learning of the mathematics education students on mathematical topics regarding their sex differences and personality differences.

2. Method

The type of this study is descriptive. The subjects of this study were 38 students of Mathematics Education Department of Universitas Halu Oleo Kendari, Indonesia, consisting of ten male and 28 female. The technique of collecting data is using a test which consists of a gender test and a mathematics ability test. The gender tests consist of 60 items that confirm the types of student personalities, namely masculine, feminine, androgynous, and undifferentiated. Based on the gender test results from 10 men can be classified into five masculine men, four feminine men, and one personality is not clear. And from 28 female students, it can be classified into seven feminine women, five masculine women, six androgynous women, and ten unclear personalities.

The gender types seen in this study are four types, namely masculine male, feminine male, feminine female, and masculine female. While the mathematics ability test consists of ten items containing geometry, trigonometry, algebra, vector, calculus, probability and series. The data analysis techniques used descriptive analysis which aims to describe the research subject based on data from variables obtained from the group of subjects studied. The descriptive analysis in this study was to describe the percentage of mathematical abilities of the Department of Mathematics Education students both regarding gender differences and regarding personality differences.

3. Results and Discussion

The results of this study are described in four categories, namely: (1) average mathematical ability based on gender differences, (2) average mathematical abilities based on personality differences, (3) mathematical abilities viewed from mathematical topics based on gender differences, and (4) mathematical ability in terms of mathematical topics based on personality differences.

3.1. Average mathematical ability based on gender differences

The average mathematical ability based on gender differences can be seen in Table 1.

| Gender | Average Mathematical Ability |
|--------|-----------------------------|
| Male   | 44.3                        |
| Female | 45.4                        |

Based on Table 1, it can be seen that the average mathematics ability of female mathematics education students is higher than that of male mathematics education students.

3.2. Average mathematical capability based on gender roles between male and female

The average mathematical ability based on gender roles between male and female can be seen in Table 2.
Table 2. Average mathematical capability based on gender roles between male and female

| Personality of Male and Female | Average Mathematical Ability |
|-------------------------------|-----------------------------|
| Masculine male                | 44,9                        |
| Feminine male                 | 46,6                        |
| Feminine female               | 48,3                        |
| Masculine female              | 37,8                        |

Based on Table 2, it can be seen that the average student's mathematical ability in feminine female mathematics education is higher than that of masculine female mathematics students. And the average mathematics ability of male students of feminine mathematics education is higher than that of male masculine mathematics education students.

3.3. Mathematical ability viewed from mathematical topics based on gender differences

Mathematical ability regarding mathematical topics based on gender differences can be seen in Table 3.

Table 3. Mathematical ability viewed from mathematical topics based on gender differences

| Mathematical Ability | Percentage (%) |
|----------------------|----------------|
|                      | Male | Female |
| Geometry             | 20   | 7,2    |
| Trigonometry         | 10   | 7,2    |
| Algebra              | 20   | 35,7   |
| Vector               | 50   | 60,7   |
| Calculus             | 100  | 89,3   |
| Probability          | 10   | 17,9   |
| Sequence and series  | 20   | 0      |

Based on Table 3, it can be seen that students' mathematical abilities of male mathematics education tend to master calculus and vector topics, while students' mathematical abilities of female mathematics education tend to master the topics of calculus, vector, and algebra.

3.4. Mathematical ability viewed from mathematical topics based on gender roles of male and female

Mathematical abilities regarding mathematical topics based on male and female gender roles can be seen in Table 4.

Table 4. Mathematical abilities are viewed from mathematical topics based on male and female gender roles

| Mathematical Ability | Percentage (%) |
|----------------------|----------------|
|                      | Masculine male | Feminine male | Feminine female | Masculine female |
| Geometry             | 20             | 25            | 28,6           | 0               |
| Trigonometry         | 20             | 0             | 0              | 0               |
| Algebra              | 40             | 0             | 42,9           | 0               |
| Vector               | 60             | 75            | 42,9           | 40              |
| Calculus             | 100            | 100           | 100            | 60              |
| Probability          | 20             | 0             | 28,6           | 40              |
| Sequence and series  | 20             | 25            | 0              | 0               |
Based on Table 4, it can be seen that students' mathematical abilities in masculine male mathematics education can master all mathematical topics, but the most dominant are topics of calculus, vectors and algebra. While students of feminine male mathematics education tend to master calculus and vector topics, and the topics of trigonometry, algebra, and probability cannot be mastered. Then for students, feminine female mathematics education tends to master the topics of calculus, vector and algebra, and cannot master trigonometry and sequence/series. While students of masculine female mathematics education tend to master the topics of calculus, vectors, and Probability, and other topics cannot be mastered.

Based on the results of these studies it can be obtained that regarding gender differences, the average student's mathematical ability of female mathematics education is higher than that of male mathematics education students. This fact is in line with the study that women's mathematical abilities outperform male classmates in the open and context problems [9]. However, the results of this study differ from the other's view that the existence of biological differences can be a source of gender differences in mathematical abilities, namely male mathematical abilities better than women [10]. This difference is caused by a lack of confidence and attitude for women to understand mathematics. Similarly, men's mathematical abilities significantly outperformed women for all cognitive levels (knowledge, skills, understanding, and applications) at all ages. This difference may reflect the most obvious influence of differential socialization and stereotypical threats on difficult and sophisticated material, resulting in doubts that can disrupt women's performance on mathematics [11]. The findings of this study are in line with the other results because the interest and motivation of students who enter the Department of Mathematics Education are higher than male students.

While male mathematics education students tend to master calculus and vector topics, and female mathematics education students tend to master calculus, vector, and algebra material. Similar findings confirmed that groups of boys rely on spatial strategies when completing mental-rotation tasks, while groups of girls tend to use verbal strategies to complete mathematical tasks [12, 13].

Then, if viewed from the gender role, it can be seen that the average mathematical ability of female mathematics math students is higher than that of masculine female mathematics education students. Likewise, the average mathematical abilities of students of feminine male mathematics education are higher compared to male masculine mathematics education students. This idea shows that students who play a feminine role have higher mathematical abilities compared to students who play masculine. Thus, it can be said that the differences in gender roles in students can affect their mathematical abilities. A similar study confirms that regardless of biological sex, gender roles influence mathematical abilities, but the masculine role is significantly better on arithmetic tests than feminine roles [14]. Likewise, gender roles can influence the level of mathematical achievement [8].

Whereas the mathematics topics mastered by students based on personality differences shows that masculine male mathematics education students tend to master the topics of calculus, vector and algebra, and students of feminine male mathematics education tend to master the topics of calculus and vector. While female students of feminine mathematics education tend to master the topics of calculus, vector and algebra, and students of masculine female mathematics education tend to master the topics of calculus, vectors, and opportunities. Thus, it can be said that differences in student personality cannot influence the mastery of topics in mathematics.

4. Conclusion
Based on the results of the research and discussion above, we may arrive at some conclusions. First, regarding gender differences, the average mathematics ability of female mathematics education students was higher than that of male mathematics education students. Furthermore, male mathematics education students tend to master calculus and vector topics, while female mathematics education students tend to master the topics of calculus, vector, and algebra. Second, regarding the differences in personality, the average student's mathematical ability in feminine female mathematics education is higher than that of masculine female mathematics education students. Likewise, the average student's mathematical ability in feminine male mathematics education is higher than that of male masculine mathematics education students.
students. Third, masculine male mathematics education students and feminine male tend to master the topic of calculus and vectors. Students of feminine female mathematics education tend to master calculus and algebra material, while students of masculine female mathematics education tend to master calculus and probability material. Forth, the differences in student personality can affect their mathematical abilities, but cannot influence the mastery of topics in mathematics.

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References
[1] Mok Y F, Fan R M and Pang N S 2007 Developmental patterns of school students’ motivational- and cognitive-metacognitive competencies Educational Studies 33 81
[2] Zimmerman B J and Martinez-Pons M 1990 Student differences in self-regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use Journal of Educational Psychology 82 51
[3] Dweck C S 1986 Motivational processes affecting learning American Psychologist 41 1040
[4] Misu L, Budayasa I K and Lukito A 2018 Profile of metacognition of mathematics pre-service teachers in understanding the concept of integral calculus with regard gender differences J. Phys. Conf. Ser. 947 12057
[5] Stake J E and Eisele H 2010 Gender and personality Handbook of Gender Research in Psychology (New York: Springer) pp 19-40
[6] Basow S A 1992 Gender: Stereotypes and roles (Belmont: Thomson Brooks/Cole Publishing Co)
[7] Bem S L 1974. The measurement of psychological androgyny Journal of Consulting and Clinical Psychology 42 155
[8] Santos D, Ursine S, Ramirez M P and Sanchez G 2006 Mathematics achievement: Sex difference vs. gender difference Psychology of Mathematics Education 5 41
[9] Leder G C 2008 Equity: The case for and against gender Proceeding of the 11th International Congress on Mathematical Education (Monterey: International Commission for Mathematics Instruction) pp 6-13
[10] Ernest P 2007 Questioning the gender problem in mathematics Philosophy of Mathematics Education Journal 20
[11] Savinainen A and Viiri J 2013 Gender differences in learning of the concept of force, representational consistency and scientific reasoning International Journal of Science & Mathematics Education 11 11
[12] Casey M B, Nuttall R L and Pezaris E 2001 Spatial Mechanical Reasoning Skills versus Mathematics Self Confidence as Mediators of Gender Differences on Mathematics Subtests Using Cross-National Gender-Based Items Journal for Research in Mathematics Education 32 28
[13] Maccoby E E and Jacklin C N 1974 The psychology of sex differences (Stanford: Stanford University)
[14] Selkow P 1985 Male/female differences in mathematical ability: A function of biological sex or perceived gender role? Psychological Reports 57 551