Relationship between mathematical creative thinking ability and student’s achievement in gender perspective

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Abstract: This study aims to obtain a comprehensive explanation of the relationship between mathematical creative thinking skills and students’ achievement from a gender perspective. The samples of this study were the 10th-grade science department students’ scores on mathematical creative thinking, and achievement, which contains 29 students (14 male students and 15 female). This research is ex post facto research. The result shows that; 1) there is a positive relationship between mathematical creative thinking ability and learning outcomes in gender perspective simultaneously, with the R coefficient is 60.4%, variation in mathematical learning achievement can be explained by variations in creative thinking ability and gender; 2) Male students’ mathematical creative thinking skills have a positive effect on mathematical learning achievement, with the R coefficient is 57.7%, variations in mathematical learning achievement can be explained by variations in the male students’ creative thinking ability; 3) The mathematical creative thinking ability of female students has a positive effect on mathematical learning achievement, with the R coefficient is 56%, variations in mathematical learning achievement can be explained by variations in female students’ creative thinking ability. The variation of male creative thinking is slightly superior to the variation of the creative thinking of the female.

1. Introduction
Mathematical creativity has now been proposed as one of the main components of 21st-century education [1]. This ensures the growth of the overall field of mathematics and mathematical creativity is one of the greatest assets of a nation [2]. The strength of a nation depends on the quality of the original knowledge and unique information. That everyone can be creative or intelligent in general, also in a certain or specific domain, but the levels may vary.

Creativity is the ability of individuals to produce things that are appropriate and new [3]. Many studies that concentrate on creative products also deal with the things that distinguish them, and how they are valued. It appears that most studies in mathematics education use definitions [4], which claim that creativity can be assessed based on originality, fluency, flexibility, and elaboration. Mathematical educators seem to have mainly used three of the four criteria: originality, fluency, and flexibility as described below [5]. Originality is a mathematical response to be original, rare and following mathematical problems [6], while originality argues that the ability to generalize or find original
evidence or the discovery of new theorems is also a creative product. It suggests that originality determines creativity in a way that is stronger than fluency and flexibility [7].

A fluent thinker is someone who can produce many ideas, possibilities, and approaches to find solutions to various problems, flexibility is the ability to give different responses to a question, by breaking the path of previously formed solutions and having the freedom to develop ideas and solutions. To achieve this, an individual needs to understand the same thing from different perspectives, to change representations, reverse procedures or even redefine ideas and change all problems (or situations) to find new ways of thinking differently [8]. Although the three components of creative products are widely used in the field of mathematical creativity, we feel that the existence of measurement methods or tools that can measure them together without overlapping or obscurity will be a major contribution. The effort was carried out by [4], who proposed a model that contained operational definitions and assessment schemes suitable for evaluating mathematical creativity.

Also, several studies have been conducted to examine gender differences related to mathematics learning, namely male and female, compared to using variables including innate abilities, attitudes, motivation, talent and performance [9]. Some researchers believe that the influence of gender factors in mathematics is due to biological differences in the brains of males and females which are known through observation that females, in general, are superior in the field of language and writing, while males are superior in the mathematics area, because of they are better in spatial abilities. Females are generally focused on things that are concrete, practical, emotional, and personal, while males are focused on things that are intellectual, abstract, and objective [10].

This gender difference makes people think about the ways of thinking, learning and conceptualizing processes that are different according to sex. So, these gender differences create differences in roles, functions, and responsibilities. Which are the results of social construction, according to the development of the times [11]. The results of these studies showed different results. From some of these studies it was found that gender differences did not play a role in the success of learning, in the sense that it could not be concluded clearly whether men or women were better at learning mathematics, and the facts showed that there were many women who were successful in their mathematical careers [12]. Learning achievement can be considered as an important part of learning, which includes cognitive, affective, and psychomotor fields. Learning achievement as the final product of learning activities is not obtained by simple methods and procedures, but learning achievement is a comprehensive description of the activities carried out by students both mental and spiritual activities. Achievement is the result that has been achieved from what has been done [13].

Several previous research studies, researchers investigated the relationship between mathematical creative thinking abilities and mathematical intelligence. The results showed that there was little correlation between mathematical creative thinking abilities and mathematical intelligence [14]. While research on investigating the tendency of creative thinking prospective mathematics teachers in terms of different variables, where the variables investigated include: self-discipline, seeking innovation, courage, doubt, flexibility, curiosity, and creativity. The creative thinking tendencies of prospective mathematics teachers are examined in terms of gender and high school graduation. Whereas in terms of gender the potential level of creative thinking of female math teacher candidates is superior in all dimensions of the variable except in the courage variable [15]. In the study of creative thinking skills based on learning styles in terms of mathematical communication skills, the results of the study show that the average creative thinking skills of students who learn kinesthetic styles are higher than visual learning styles [16]. From several studies of literature studies conducted by previous researchers, still, have not found research that looks for a relationship between mathematical creative thinking abilities and student achievement in a gender perspective. Therefore, researchers want to expand the study of mathematical creative thinking skills, gender and mathematics learning achievement.
2. Methods
The type of design in this study is a correlational study that aims to see the relationship between mathematical creative thinking skills and student achievement in terms of gender. The methodology used in this study is a quantitative method. The research design in this study is described in the following diagrams.

![Diagram showing the relationship between Mathematical Creative Thinking Ability (X1), Gender (X2), and Student Learning Achievements (Y).](image)

**Figure 1.** Framework for Multiple Correlation Thinking

Figure 1 shows that mathematical creative thinking ability (X1) and Gender (X2) are independent variables while mathematical learning achievement (Y) is the dependent variable.

3. Result and Discussion
Data analysis was performed with SPSS-23. Data analysis of mathematical creative thinking skills and gender on student achievement simultaneously using multiple regression analysis. The regression assumption test has been fulfilled, namely normally distributed data, fulfilling the criteria of multicollinearity, autocorrelation, heteroscedasticity, and linearity, so the next step is to test the hypothesis as follows:

3.1. There is a Positive Relationship between Mathematical Creative Thinking Abilities and Student Learning Achievements viewed from Gender.

The results showed that mathematical creative thinking ability with student achievement in terms of gender can be seen in the determination coefficient summary model in Table 1.

| Model | R    | R Square | Adjusted R Square | Std. An error of the Estimate |
|-------|------|----------|-------------------|------------------------------|
| 1     | .777 | .604     | .574              | 6.630                        |

a. Predictors: (Constant), Mathematical Creative Thinking Ability and Gender
b. Dependent: Student Learning Achievement

Based on the results of the analysis from Table 1, the adjusted R squared ($r^2$) value is 0.604 or 60.4%. This means that the relationship between mathematical and gender creative thinking skills simultaneously on students’ mathematical learning achievement is 60.4%. The remaining 39.6% is influenced by other factors. In other words, variations in mathematical learning achievement variables can be explained by variations in the variables of mathematical creative thinking ability in terms of gender by 60.4%, while the relationship of 39.6% is caused by another variability outside the research model. The regression equation for this model can be seen in Table 2.

| Model                      | Unstandardized Coefficients | Standardized Coefficients | t     | Sig. |
|----------------------------|----------------------------|---------------------------|-------|------|
| (Constant)                 | 29.626                     | 8.329                     | 3.557 | .001 |
| Mathematical Creative Thinking Ability | .620                      | .107                      | .713  | 5.777 .000 |
| Gender                     | 6.319                      | 2.464                     | .316  | 2.564 .016 |
a. Dependent Variable: Student Learning Achievement

Table 2 explains the magnitude of the influence of the ability of creative thinking and gender on students' learning achievement. This is shown in the Beta number or Standardized Coefficient. From the beta number, the relationship between mathematical creative thinking ability is 0.713 and gender is 0.316, both of these abilities are significant, where the significance of creative thinking ability is 0.000 < 0.05, and the gender significance value is 0.016 < 0.05. There is a positive relationship between mathematical creative thinking skills (originality, fluency, flexibility) with gender (14 male students and 15 female students) towards the learning achievement with the regression equation: 

\[ Y = 29.626 + 0.620X1 + 6.319X2. \]

This is in line with research that says a teacher must develop more creative teaching methods to teach 21st-century generation students, previous research has shown that developing students' creative thinking can significantly influence creativity and student achievement [17]. Research findings show: 1) the extraordinarily positive effect of teaching web-based creative thinking on creativity; 2) significant effects of creativity are recorded on learning outcomes, and 3) significant positive effects of teaching web-based creative thinking on learning outcomes [18]. But creative people are most creative not as a result of certain innate traits, but through attitudes towards life in response to any problems that come, they are accustomed to responding to problems in new and unique ways [13]. To improve students' creative abilities, learning must be developed and accustomed to non-routine problems that deliver the habits of students to think creatively in mathematics classes to improve students' mathematical learning achievement.

3.2. There is a Positive Relationship between Male Students' Mathematical Creative Thinking Abilities with Student Learning Achievements.

The results of the study show that, relation between male students' mathematical creative thinking abilities with student achievement can be seen in the determination coefficient summary model in Table 3.

| Model | R | R Square | Adjusted R Square | Std. An error of the Estimate |
|-------|---|----------|------------------|-----------------------------|
| 1     | .759* | .577     | .544             | 5.315                       |

a. Predictors: (Constant), Mathematical Creative Thinking Abilities

Based on the results of the analysis from Table 3, we obtained the adjusted R squared ($r^2$) of 0.577 or 57.7%. This number means that the relationship between mathematical creative thinking abilities of male students with students' mathematical learning achievement is 57.7%. The remaining 42.3% is influenced by other factors. In other words, variations in mathematical learning achievement variables can be explained by variations in the male students' mathematical creative thinking ability of 57.7%, while the relationship of 42.3% is due to another variability outside the research model. While the regression equation for this model can be seen in Table 4.

| Coefficients | Model | Unstandardized Coefficients | Standardized Coefficients |
|--------------|-------|-----------------------------|--------------------------|
|              | B     | Std. Error                  | Beta                     |
| 1 (Constant) | 46.252| 9.166                       | 5.046.000                |
| Mathematical Creative Thinking Abilities | .561 | .133 | .759 | 4.209 | .001 |

a. Dependent Variable: Student Learning Achievements

From Table 4, to find out the magnitude of the influence of the creative thinking abilities of male students on learning achievement, Beta number or Standardized Coefficient is used. From the beta number, the mathematical creative thinking ability of men is 0.759. This means that the magnitude of
the relationship between mathematical creative thinking abilities of male students with learning achievement is 0.759, if creative thinking skills increase or decrease one level, then students' mathematical learning achievements will also increase or decrease one level. This significant number is equal to \( = 0.001 < 0.05 \). It can be concluded partially that; there is a significant positive relationship between mathematical creative thinking skills between male students with mathematical learning achievement in class X Laboratory High School of Universitas Pendidikan Indonesia (UPI), the regression equation: \( Y_p = 46.252 + 0.561X1 \). This is in line with several previous research studies which say that the influence of gender factors in mathematics is due to biological differences in the intelligence of males and females students which are known through observation, that girl. Men and women have differences in learning attitudes; for example, women usually use more learning strategies than men. This difference in characteristics can affect their skimming abilities. In terms of ability between men and women, there is no essential difference, but the difference lies in attitude [19].

3.3. There is a Positive Relationship between Female Students' Mathematical Creative Thinking Abilities with Student Learning Achievements.

The results of the study show that the mathematical creative thinking abilities of female students with student achievement can be seen in the determination coefficient summary model in Table 5:

| Model | R   | R Square | Adjusted R Square | Std. An error of the Estimate |
|-------|-----|----------|------------------|-----------------------------|
| 1     | .748* | .560     | .523             | 7.992                       |

a. Predictors: (Constant), Mathematical Creative Thinking Abilities

Based on the results of the analysis from Table 5 of the above summary model, we obtained an adjusted R squared \((r^2)\) of 0.560 or 56%. This number means that the relationship between mathematical creative thinking abilities of female students on students' mathematical learning achievement is 56%. The remaining 44% is influenced by other factors. In other words, variations in mathematical learning achievement variables can be explained by variations in the variable ability of female mathematical creative thinking by 56%, while the relationship of 44% is caused by another variability outside the research model. The regression equation for this model can be seen in Table 6.:

| Model                     | Unstandardized Coefficients | Standardized Coefficients | t | Sig. |
|---------------------------|----------------------------|---------------------------|---|------|
| (Constant)                | 33.091                     | 11.739                    | 2.819 | .015 |
| Mathematical Creative Thinking Abilities | .661 | .169 | .748 | 3.909 | .002 |

a. Dependent Variable: Student Learning Achievements

From Table 6, the beta number obtained female mathematical creative thinking skills of 0.748. This means that the magnitude of the relationship between mathematical creative thinking skills of female students with learning achievement is 0.748, if creative thinking skills increase or decrease one rank then students' mathematical learning achievement increase or decrease one rank. The significant number of this ability is \( = 0.002 < 0.05 \), so it can be concluded partially that; there is a significant positive relationship between mathematical creative thinking skills among female students with mathematical learning achievement in class X Laboratory High School of Universitas Pendidikan Indonesia, with the regression equation: \( Y_p = 33.091 + 0.661X1 \). Based on relevant research, gender issues in research on mathematical creativity are limited. Among the relevant studies that were carried out more than 50 years ago. Specifically [4] reported that most women surpassed their male
counterparts in creative mathematics tests, finding gender differences was significant only in grades seven and eight, whereas there were no gender differences found in grades five and six. Similarly, concluding with a significant average difference in the score of creativity, women are preferred. This is contrary to the results of this study, which resulted in the mathematical creative thinking ability of male student’s superior to female students in terms of mathematical creativity with a difference in the R squared coefficient of 1.7% or by considering the beta number difference of 0.011.

4. Conclusion

Based on the results and discussion of the relationship between mathematical creative thinking skills, gender and learning achievement can be concluded: (1) there is a positive relationship between the ability to think creatively with gender in terms of mathematical learning achievement; (2) there is a positive relationship between creative thinking ability between male students with mathematical learning achievement; (3) there is a positive relationship between creative thinking skills between female students with mathematical learning achievement.

5. References

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