Research Article

Mathematical Reasoning Ability and Mathematics Self-efficacy in Gender Differences

Habibi Ratu Perwira Negara[1,2*], Wahyudin[1], Elah Nurlaelah[1], Marzuki[3], Farah Heniati Santosa[4], Samsul Bahri[4]

[1]Department of Mathematics Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229, Bandung 40154, Indonesia
[2]Department of Mathematics Education, Universitas Islam Negeri Mataram, Jl. Gajah Mada Pagesangan No. 100, Nusa Tenggara Barat, 83116, Indonesia
[3]Department of Mathematics Education, Institut Agama Islam Negeri Langsa, Jl. Meurandeh, Langsa 24354, Indonesia
[4]Department of Mathematics Education, Universitas Nahdlatul Wathan Mataram, Jl. Kaktus No 1-3, Nusa Tenggara Barat, 83125, Indonesia

ORCID
Habibi Ratu Perwira Negara: https://orcid.org/0000-0002-7573-8961

Corresponding Author: Habibi Ratu Perwira Negara; email: habibiperwira@uinmataram.ac.id

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Abstract.
Gender differences and aspects of self-efficacy are factors influencing the success of the mathematics learning process. This study aims to obtain an explanation of mathematical reasoning abilities based on gender differences in terms of mathematical self-efficacy. The sample of this research is a collection of scores of mathematical reasoning abilities, gender differences, and mathematical self-efficacy scores of XIth grade students from a high school in Bandung. The research sample consisted of 35 students, consisting of 19 male and 16 female students. The research instruments were tests of mathematical reasoning abilities (MRA), gender differences, and a mathematics self-efficacy (SEM) questionnaire. Data analysis was done using ANACOVA, with MRA in the form of interval scale, gender category scale, and SEM as covariate with interval scale. The results of the study were as follows: (1) there is a linear relationship between mathematical self-efficacy and mathematical reasoning ability; (2) there is no difference in students' mathematical reasoning abilities based on gender differences. Furthermore, SEM students and gender differences have an influence on the MRA achieved by students.

Keywords: gender differences, mathematical reasoning ability, mathematics self-efficacy.

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1. INTRODUCTION

Reasoning skills are widely used in mathematics, and they are one of the fundamentals for success in other disciplines, as well as the foundation for developing students' cognitive aspects [1] Reasoning during mathematics learning can improve students' cognitive capabilities in developing mathematical hypotheses and reasoning logically

[2]. Student intellect is measured by reasoning abilities, which cannot be isolated from mathematics learning [3]. Reasoning ability promotes students to a deeper understanding of mathematical topics and is a prerequisite for success in other courses [2]. During the teaching and learning process, the mathematical reasoning concept aims to train students to link one context of a mathematics issue to another.

According to [4], low students' mathematical reasoning influences students to have high levels of math anxiety, which does not lead to their mathematical learning capacity. Experts advocate incorporating mathematical reasoning into the school curriculum and incorporating it into the teaching and learning process [5]. As a result, learning methodologies and instructors' roles are critical for strengthening student thinking during the teaching and learning process.

Reasoning, which is the foundation of all mathematical principles and processes, may be used to comprehend mathematical reality [6]. According to [7], The following activities are part of mathematical reasoning: (1) Reasoning allows for the reconstruction of mathematical knowledge when it is learned conceptually; (2) Reasoning allows for the revelation and discovery of new mathematical thoughts; (3) Reasoning allows for the verification and proof of mathematical propositions; (4) Reasoning aids students in the generalization of special conditions; and (5) Reasoning allows for the synthesis of mathematical concepts and operations.

Mathematical reasoning is a typical activity that includes strategies such as induction, deduction, association, and inference, as well as how students communicate with one another to solve issues [8]. Reasoning is described as a task that is much above the thinking process and the effort of fully thinking about all parts of the issue, event, or circumstance and so obtaining a logical conclusion [9]. National curriculum [10] and worldwide reforms and studies [9] underline the importance and function of mathematical reasoning in learning. It is said that (1) there is a link between mathematics learning and reasoning, (2) effective solutions may be discovered if a person utilizes reasoning to solve a problem, and (3) they can build better associations as a result [11].

Gender differences are one of the factors that affect mathematical reasoning abilities [12, 13]. Gender differences lead to differences in the learning strategies students use in mathematical reasoning [12, 14–16]. Male students prefer to employ metric calculations and concentrate on the essential points of the studies, whereas female students prefer to apply traditional and well-known tactics [12, 16, 17]. Female students tend to apply the tactics taught to them by their professors, whereas male students invent new tactics and think more abstractly [9]. Female students use their fingers to do addition and subtraction computations, whereas male students use mental computation [18]. Male students consider a wide range of possibilities in their thinking and, as a result, attempt to employ a variety of tactics [19].

The affective aspect of mathematical self-efficacy also determines the success of learning mathematics. Previous research has reported that mathematical self-efficacy is a factor in students' success in completing math tasks [20] [21]. Mathematical self-efficacy as an individual's confidence in their ability to organize and implement certain programs to solve problems or complete tasks [22–24]. Students with high self-efficacy will help them to create feelings about dealing with complex problems or activities, otherwise someone with low self-efficacy will quickly give up in dealing with problems and have a narrow view of the best strategy to solve the problem.

Looking at the explanation above, mathematical self-efficacy can be seen as an output factor that also affects mathematical reasoning abilities. Therefore, researchers are interested in studying mathematical self-efficacy as a controlled variable or covariate, this is in line with the research idea [25]. The design of this study is new, considering that researchers have not found related studies that examine differences in students' mathematical coloring abilities based on gender differences by controlling for mathematical self-efficacy variables. so that the aim of the research is to obtain an explanation of students' mathematical reasoning abilities based on gender differences in terms of mathematical self-efficacy. Based on the research objectives, the research questions posed were (1) whether there is a linear relationship between mathematical self-efficacy and mathematical reasoning abilities; (2) whether there are differences in mathematical reasoning abilities based on gender differences and (3) whether simultaneously SEM students and gender differences have an effect on the MRA obtained by students.

2. RESEARCH METHOD

A This study is an expost-facto study with the aim of obtaining an explanation of mathematical reasoning abilities based on gender differences in terms of mathematical self-efficacy. The research design is in the form of comparing (causal comparative) students' mathematical reasoning abilities based on gender in terms of mathematical self-efficacy. The sample of this research is a collection of mathematical reasoning ability scores, gender differences, and mathematical self-efficacy scores of XI high school students in a school in Bandung. The cluster random sampling technique was used in determining the research sample which was spread over 3 classes. The research sample consisted of 35 students consisting of 19 male students and 16 female students.

The research instrument was a mathematical reasoning ability test (MRA), and a mathematical self-efficacy questionnaire (SEM). The MRA test consists of 5 essay questions with indicators such as (1) Memorized Reasoning, (2) Algorithmic Reasoning, (3) Novelty, (4) Plausible, and (5) Mathematical foundation. While the self-efficacy questionnaire consists of 20 items using a Likert scale of 1-4 measurements. The indicators of the self-efficacy questionnaire include (1) the magnitude dimension, namely how students can overcome their learning difficulties; (2) Strength dimension, which is how high students' confidence in overcoming their learning difficulties; and (3) the Generality dimension related to the need to take place in a particular domain or to be required in various activities and related activities. Analysis of research data using ANACOVA with the help of SPSS-25. The use of ANACOVA considering that the research variable consists of the dependent variable, namely the ability to reason mathematically, the independent variable in the form of gender differences and SEM which is also seen as a covariate variable.

3. RESULT AND DISCUSSION

The aim of research to obtain an explanation of mathematical reasoning abilities based on gender differences in terms of mathematical self-efficacy. Table 1 shows the findings of descriptive statistics on data on students' mathematical reasoning skills (MRA) based on gender disparities.

Table 1: Descriptive statistics of MRA score based on gender differences.

Gender	**Mean**	**Std. Deviation**	**N**
Male	70.2632	11.72292	19
Famale	77.5000	13.78405	16
Total	73.5714	13.03679	35

Based on Table 1 above, it is known that the number of male students was 19 students with an average MRA score of male students obtained at 70.26 with a standard deviation of 11.72. There were 16 female students with an average MRA score of 77.50 with a standard deviation of 13.03. While the average MRA overall score was 73.57 with a standard deviation of 13.03.

The next statistical analysis was in the form of hypothesis testing. The test statistic used is ANACOVA, where the SEM variable is a controlled variable or covariate. Table 2 shows the findings of the MRA data analysis based on gender disparities in terms of SEM.

Table 2: MRA score based on gender differences in terms of SEM.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1384.479[a]	2	692.240	5.041	.012
Intercept	479.458	1	479.458	3.492	.071
SEM_score	929.592	1	929.592	6.770	.014
Gender	449.025	1	449.025	3.270	.080
Error	4394.092	32	137.315		
Total	195225.000	35			
Corrected Total	5778.571	34			

a. R Squared = .240 (Adjusted R Squared = .192)

Table 2 above shows that the significance for SEM_ Score is 0.014. because the Sig. <0.05, H0 is rejected. This suggests that there is a linear relationship between mathematical self-efficacy (SEM) and mathematical reasoning abilities (MRA) at a 95% confidence level. This statement indicates that the ANCOVA assumption has been fulfilled. This test is carried out by first removing the effects of the model's gender disparities. This is in line with findings [20][21] which state that differences in mathematical self-efficacy affect the results of students' mathematical reasoning abilities.

Furthermore, testing was carried out to determine the effect of gender differences on MRA obtained by students. This test is done by removing the influence of SEM from the model. From the processing results, it can be seen (Table 2) that the significance for gender differences is 0.080. Because the value is far above 0.05, H0 is not rejected. So it can be concluded that without the influence of SEM, at the 95% confidence level there is no effect of gender differences on the mathematical reasoning abilities (MRA) obtained by students. This is reinforced by the average mathematical reasoning ability obtained (see Table 1), where the average MRA score of male students (70.26) is not significantly different from the average MRA score of female students (77.5). This result is in line with findings [26, 27] which state that students' mathematical reasoning abilities between boys and girls are not significantly different. However, these findings reinforce that SEM is one of the affective factors that needs to be reviewed in a learning process. This is based on the analysis process performed, in which the SEM influence of the model is demonstrated. thus, MRAs based on gender differences do not differ significantly. Male and female students exhibit varied levels of self-efficacy, as seen by how they respond to an issue at hand. Females are more likely to utilize feelings to solve problems, whilst males are more rational. Men have rational reasoning, whilst women have feelings [28].

These distinctions will have an impact on the mathematical abilities of male and female students [29].

The significant values in the Corrected Model section can be used to assess the influence of student SEM and gender differences on MRA received by students concurrently. The significance figure is 0.012, as may be seen. H_0 is rejected since the significance value is considerably below 0.05. As a result, at a 95% confidence level, it is possible to infer that both SEM students and gender differences have an influence on the MRA achieved by students [20, 21].

Empowerment of mathematical self-efficacy is an effort to improve the quality of learning. The results of this study indicate that the affective aspect of mathematical self-efficacy is one of the factors that determine the success of learning mathematics [28, 29]. This fact reinforces that teachers are encouraged to be able to observe aspects of self-efficacy that influence the mathematics learning process. Apart from the research results reported, certain limitations of this study must be considered. The sample obtained is limited to class XI high school students who are in one of the schools in the city of Bandung, so that the sample expansion is expected to be generalized.

4. CONCLUSION

In this study, mathematical reasoning abilities, gender differences and self-efficacy were studied. The results showed that there was a linear relationship between mathematical self-efficacy and mathematical reasoning abilities. there is no difference in mathematical reasoning abilities based on gender differences. Furthermore, SEM students and gender differences have an influence on the MRA achieved by students.

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