

# NO GENDER DIFFERENCES IN MATHEMATICAL PROBLEM-SOLVING ABILITY: A STUDY WITH MATHEMATICS ANXIETY CONTROL

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**ABSTRACT** Equality, including gender, is an essential principle in school mathematics education and learning. Previous research findings, however, have yielded mixed results in terms of students' mathematics proficiency, particularly mathematical problem-solving abilities. Furthermore, mathematics anxiety is frequently related to a decline in these abilities. As a result, the purpose of this study is to examine gender disparities in students' mathematical problem-solving abilities while accounting for the influence of students' mathematics anxiety. This study used a survey method with 96 students chosen by cluster sampling from a public junior high school in an urban area. This study included two instruments: a mathematical problem-solving abilities test and a mathematics anxiety scale. The findings of this study show that: (1) there is no significant difference in students' mathematics anxiety based on gender, (2) gender has no significant effect on students' mathematical problem-solving abilities after controlling for mathematics anxiety, and (3) mathematics anxiety has a significant effect on mathematical problem-solving abilities after controlling for gender. These findings highlight the need for strategies for reducing mathematics anxiety in children. Comprehensive assistance from the learning environment, including the responsibilities of parents, teachers, and friends, as well as a positive learning environment, is intended to assist students in overcoming mathematics anxiety. Thus, this study has significant implications for the development of inclusive and successful mathematics learning strategies.

**Keywords:** ancova, gender, mathematical problem-solving ability, mathematics anxiety.

**ABSTRAK** Kesetaraan, termasuk kesetaraan gender, merupakan salah satu prinsip penting dalam pendidikan dan pembelajaran matematika di sekolah. Namun, berbagai temuan penelitian sebelumnya menunjukkan hasil yang beragam terkait performa siswa dalam matematika, khususnya dalam kemampuan pemecahan masalah matematis. Di sisi lain, kecemasan terhadap matematika sering kali dikaitkan dengan penurunan kemampuan ini. Oleh karena itu, penelitian ini bertujuan untuk menganalisis perbedaan kemampuan pemecahan masalah matematis siswa berdasarkan gender dengan mengontrol pengaruh kecemasan matematika. Penelitian ini menggunakan metode survei terhadap 96 siswa yang dipilih melalui teknik cluster sampling di salah satu SMP Negeri di daerah perkotaan.

Instrumen yang digunakan meliputi tes kemampuan pemecahan masalah matematis dan skala kecemasan matematika. Hasil penelitian menunjukkan bahwa: (1) tidak terdapat perbedaan signifikan dalam kecemasan matematika antara siswa laki-laki dan perempuan; (2) gender tidak memiliki pengaruh signifikan terhadap kemampuan pemecahan masalah matematis setelah mengontrol kecemasan matematika; dan (3) kecemasan matematika memiliki pengaruh signifikan terhadap kemampuan pemecahan masalah matematis setelah mengontrol faktor gender. Temuan ini menekankan pentingnya intervensi untuk mereduksi kecemasan matematika pada siswa. Dukungan dari lingkungan belajar, termasuk peran orang tua, guru, dan teman sebaya, serta suasana pembelajaran yang kondusif, diharapkan mampu membantu siswa dalam mengatasi kecemasan terhadap matematika. Dengan demikian, penelitian ini memberikan implikasi penting bagi pengembangan strategi pembelajaran matematika yang lebih inklusif dan efektif.

**Kata-kata kunci:** ancova, gender, kecemasan matematika, kemampuan pemecahan masalah matematis.

## INTRODUCTION

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Problem-solving is a fundamental domain of mathematics education and learning. As a result, it is not surprising that problem-solving is one of the competencies of school mathematics, alongside reasoning and proof, communication, connections, and representation (NCTM, 2000). Nisa et al. (2024) explained that problem-solving allows students to apply their existing mathematics knowledge and abilities to tackle problems. This suggests that problem-solving is a method, process, and aim for implementing mathematics learning.

Problem solving is one of the talents that students must possess in mathematics, namely the ability to solve mathematical problems. Kour & Rafaqi (2024) describe mathematical problem-solving ability as an individual's ability to analyze, comprehend, and solve mathematical problems. This ability is defined as an individual's ability to solve problems in mathematics and other contexts, build new knowledge through problem-solving, monitor and reflect on the mathematical problem-solving process, and apply and adapt various appropriate problem-solving strategies (Maya & Sumarmo, 2011; NCTM, 2000). These indicators can be used to assess mathematical problem-solving abilities as part of the development activities.

The most fundamental effort to improve mathematical problem-solving abilities occurs during the learning process in mathematics classes. One of the most fundamental aspects of establishing school mathematics teaching and learning is equality. NCTM (2000) emphasizes that all students should have the chance to learn and get assistance in comprehending mathematics. This equality encompasses gender. However, past studies have yielded conflicting results about student performance, particularly mathematical problem-solving ability dependent on gender. Male students outperform female students in mathematical problem-solving, according to studies by Heidari & Rajabi (2017) and Zhu (2007). Meanwhile, Pujiastuti's (2015) investigation yielded the opposite results. The disparity in student performance in problem-solving is further explained by Nafi'an's (2021) study, which

discovered that male students succeed at employing reasoning in mathematical problem-solving, but females excel at analytical thinking and accuracy in the same situations. Ajai & Imoko (2015) and Devine et al. (2012), found no difference in students' mathematical problem-solving abilities based on gender. As a result, this study is expected to fill a gap by investigating the link between gender and mathematical problem-solving ability.

Mathematics anxiety is one of the factors thought to be associated with and influences students' mathematical performance, especially their mathematical problem-solving abilities. Zakariya (2018) defines mathematics anxiety as a negative psychological reaction characterized by fear, worry, a lack of self-confidence, and tension about number manipulation activities. According to prior research, mathematics anxiety is frequently connected with lower student performance in mathematics (Devine et al., 2012; Kyttälä & Björn, 2014; Möhring et al., 2024). As a result, the purpose of this study is to fill a vacuum in the literature by investigating the association between gender and mathematical problem-solving ability while controlling for the influence of mathematics anxiety. This study's results are expected to provide a more thorough knowledge of the connection between gender and mathematics anxiety in mathematics learning.

## **METHODS**

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This is a quantitative survey study of 96 students, 43 male and 53 female, selected using cluster sampling at a public junior high school in an urban area. The participants in this study were selected from a public junior high school that follows Indonesia's zoning system. This policy aims to ensure equitable access to education by distributing students from various academic backgrounds more evenly across schools (Kemendikbud, 2018). Consequently, this diversity may influence their problem-solving approaches and interactions during learning.

The instruments used in this study were a mathematical problem-solving test and a mathematics anxiety scale. The mathematical problem-solving test was developed based on the adaptation of indicators from NCTM (2000) and Sumarmo (2012) which have been described previously. Meanwhile, the mathematics anxiety scale used in this study was developed by adapting the instrument developed by Zakariya (2018). Both instruments were used after going through expert judgment. In addition, the mathematics anxiety scale has also been proven valid and reliable and has a relatively high reliability (0.874).

Data analysis used in this study was carried out descriptively and inferentially, with the statistical test used as the ANCOVA test. The ANCOVA test was chosen to increase precision in testing differences in students' mathematical problem-solving abilities based on gender by controlling the influence of their mathematical anxiety. In conducting this analysis, the researcher was assisted by Jeffreys's Amazing Statistics Program (JASP) software.

## FINDING AND DISCUSSION

This study intends to evaluate differences by gender in students' mathematical problem-solving abilities while controlling for mathematics anxiety. According to prior research, mathematics anxiety is frequently connected with lower student performance in mathematics, although the role of gender produces mixed results. The following are the study's conclusions, which were obtained by descriptive and inferential analyses.

**Table 1.** Descriptive Statistics of Students' Mathematical Problem-Solving Ability

Gender	N	Mean	SD	SE	Coefficient of Variation
M	43	11.279	6.033	0.920	0.535
F	53	12.396	4.655	0.639	0.375

Ideal Score: 40

Table 1 presents data on the mathematical problem-solving ability scores of male and female students. Descriptively, the average score of female students' mathematical problem-solving ability is slightly higher than the average score of male students' mathematical problem-solving ability. However, by adapting the criteria for gradation of students' mathematical ability scores (Dzulfikar & Herman, 2023; Maya & Sumarmo, 2011), students' mathematical problem-solving ability is relatively low. This finding supports previous studies (Dzulfikar & Herman, 2023; OECD, 2019; Phonapichat et al., 2014; Sumirattana et al., 2017) which found that students have difficulty in solving problems that require mathematical problem-solving abilities. Additionally, the data shows a large variation in scores, indicating that some students may excel while others struggle significantly in mathematical problem-solving. One of the reasons for students' low achievement is their habit of solving only routine mathematical problems (Nizar et al., 2018). As a result, many students make errors when working on problems. These findings align with Wijaya's et al. (2014) research, which revealed that students struggle with solving context-based mathematical problems and converting them into mathematical forms.

This phenomenon is suspected to be related to the learning loss that occurred during the Covid-19 pandemic a few years ago. Several studies have shown that students' mathematical abilities declined during the pandemic compared to the previous period (Kuhfeld et al., 2021, 2022; Kuhfeld & Tarasawa, 2020; Lewis et al., 2021; Patrinos et al., 2022). Although there has been an upward trend since 2021, the progress has not yet reached a significant level. In light of these findings, it is believed that efforts can be made to overcome it, such as by implementing effective learning orientated towards mathematical thinking or differentiated instruction to accommodate students' needs that enhances student activity, particularly cognitively, by paying attention to factors that support and hinder it.

Mathematics anxiety is one of the factors thought to be associated with and influences students' mathematical performance, especially their mathematical problem-solving abilities. Table 2 shows the descriptive statistics of mathematics anxiety among the students who participated in this study.

**Table 2.** Descriptive Statistics of Students' Mathematics Anxiety

	MA	
	M	F
Valid	43	53
Missing	0	0
Mean	44.837	46.151
Std. Deviation	8.092	9.359
Minimum	26.000	27.000
Maximum	59.000	71.000

Highest Score: 75

The findings in Table 2 show that the average score of students' mathematics anxiety is slightly greater than that of male students. Referring to the guidelines for grading the attitude scale given by Azwar (2012), the scores of male and female students' mathematics anxiety are classified as moderate. This supports previous research that has yielded similar findings (Segumpang & Tan, 2018). Therefore, these findings deserve attention, as Al Mutawah's (2015) study states that students' math anxiety tends to increase as the complexity of the material they learn increases. When viewed from the distribution of the scores, the scores of female students' mathematics anxiety are more spread out than the scores of male students. This is demonstrated by the standard deviation of female students' mathematics anxiety, which is likewise greater than the standard deviation of male students' scores. Even so, statistical testing revealed that the difference in anxiety scores between male and female students was not significant, as shown in Table 3.

**Table 3.** Results of the Test of Differences in Average Scores of Students' Mathematics Anxiety

	t	df	p
MA	-0.726	94	0.470

$\alpha = 0,05$

The results of the t-test as shown in Table 3 provide information that statistically there is no difference in mathematics anxiety scores between male and female students. This is different from previous studies which found that female students showed higher mathematics anxiety than male students (Devine et al., 2012; Kyttälä & Björn, 2021; Mutodi & Ngirande, 2014). However, based on the data distribution and highest scores in Table 2, it appears that mathematics anxiety is more prevalent

among female students. Although the reasons behind this are not fully understood, Devine et al. (2012) highlighted that various socialization patterns during childhood can influence the anxiety experienced by male and female students in particular situations.

Although there is no difference in math anxiety by gender when compared to the average, variations in math anxiety among individuals are thought to be linked to differences in student performance in mathematics, particularly mathematical problem-solving. As a result, the following describes the study's findings in terms of analyzing students' mathematical problem-solving ability based on gender while controlling for math anxiety. Table 4 shows the findings.

**Table 4.** Results of the Test of Differences in Average Scores of Mathematical Problem-Solving Ability Based on Gender by Controlling for Mathematics Anxiety

Cases	Sum of Squares	Df	Mean Square	F	P	$\eta^2$
Gender	43.191	1	43.191	1.659	0.201	0.016
MA	234.651	1	234.651	9.015	0.003	0.087
Residuals	2420.679	93	26.029			

$\alpha = 0,05$

Table 4 presents the finding that there is no significant effect of gender on students' mathematical problem-solving ability after controlling for their mathematics anxiety ( $p=0.201$  and  $\eta^2=0.016$ ). Based on these findings, it is possible to conclude that gender has a minor and inconsequential effect on these abilities. This finding supports earlier research that found no gender difference in students' mathematics ability (Ajai & Imoko, 2015; Devine et al., 2012; Frenzel et al., 2007). The absence of this difference is thought to be related to the education system or pattern that is generally applied in Indonesia. Where in the practice of implementing education and learning in schools, there is no distinction between male and female students. This is as explained by Sumar (2015) that both male and female students have access, obligations, and equal positions and roles in education and learning. Furthermore, NCTM (2000) emphasizes equality as a key component and concept in the implementation of school mathematics education and learning. As a result, it is not surprising that gender has little or no influence on students' mathematical problem-solving abilities. The consequence is that other factors can influence students' ability to solve mathematical problems.

Mathematics anxiety is another factor influencing students' mathematical problem-solving abilities, according to the data in Table 4. Mathematics anxiety shows a significant effect on students' mathematical problem-solving ability ( $p = 0.003$  and  $\eta^2 = 0.087$ ). These results are in line with the findings of previous studies as previously described that mathematics anxiety has a negative effect on students' mathematical problem-solving ability (Devine et al., 2012; Kyttälä & Björn, 2014;

Möhring et al., 2024). Based on the effect size classification given by Cohen (1988), the value of  $\eta^2 = 0.087$  is included in the medium category (medium effect size). This suggests that mathematics anxiety has a considerable effect on problem-solving abilities, even after controlling for other variables, such as gender. This impact size value might be considered rather substantial in the context of education, as mathematics anxiety is frequently connected with student performance in cognitive activities such as mathematical problem-solving.

The description suggests that associated parties must interfere in students' complete learning environment to prevent mathematics anxiety, which can have a detrimental impact on their performance in mathematics, particularly while solving mathematical problems. These interventions encompass the students' social environment (parents, teachers, and friends), the learning environment, and the mathematics teaching and learning process in schools (Frenzel et al., 2007; Kyttälä & Björn, 2014). Comprehensive support for students in overcoming mathematics anxiety is predicted to help them perform better in mathematics, particularly in their mathematical problem-solving abilities.

## **CONCLUSIONS AND RECOMMENDATIONS**

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The objective of this study was to find whether gender influences students' mathematical problem-solving abilities while controlling for students' mathematics anxiety. Several conclusions were drawn from the data analysis. First, students' mathematical problem-solving abilities are rather low. The second finding in this study is that both male and female students experience modest levels of math anxiety. Third, there is no variation in students' mathematics anxiety by gender. After adjusting for mathematics anxiety, the researchers discovered that gender has no significant effect on students' mathematical problem-solving abilities. Finally, even after controlling for other variables such as gender, mathematics anxiety has a significant impact on problem-solving abilities. Based on these findings, it is hoped that students will receive comprehensive support and interventions for the entire student learning environment, including the student's social environment (parents, teachers, and friends), learning environment, and mathematics teaching and learning process, to reduce and overcome mathematics anxiety in students. Thus, this study has significant implications for the development of inclusive and effective mathematics learning strategies.

Although the study benefits from the heterogeneous student composition resulting from the zoning policy, the findings cannot be broadly generalized beyond the public school system or to regions with different socio-economic contexts. Further research with a wider scope is needed to explore this limitation.

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