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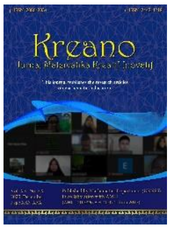

Interrelationship of Mathematical Problem-Solving Ability, Mathematical Disposition, and Gender among Grade 10 Students

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Abstracts

Although numerous studies have examined mathematical disposition (MD) and mathematical problem-solving (MPS) ability, a significant gap remains in understanding their interaction with gender differences. This study aimed to analyze the effect of MD on MPS, investigate gender-based differences, and identify the most influential MD indicators. Conducted in South Sulawesi, Indonesia, this research involved 300 tenth-grade students using an ex-post facto quantitative design. The instruments comprised a mathematical problem-solving test and a mathematical disposition questionnaire. Data were analyzed using descriptive and inferential statistics. The findings indicated that 77.6% of students were classified as having low MD, while 71.0% exhibited similarly low levels of MPS. MD significantly affected MPS (59.5%), with the indicator 'appreciation of the value of mathematics' making the largest contribution (0.293). Significant gender differences emerged in MD, whereas no such differences were observed in MPS. These findings highlight the importance of innovative and differentiated teaching strategies that prioritize improving students' MD. Such strategies are essential for fostering inclusive, responsive, and equity-oriented mathematics education, a commitment that educators and policymakers should actively strive to uphold.

Keywords: Mathematics disposition, Mathematics problem solving, Gender; Mathematics Disposition Indicators

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Abstrak

Meskipun banyak penelitian telah mengeksplorasi disposisi matematis (DM) dan kemampuan pemecahan masalah matematika (MPS), kesenjangan signifikan masih ada dalam memahami interaksinya dengan perbedaan gender. Penelitian ini bertujuan untuk menganalisis pengaruh DM terhadap MPS, mengeksplorasi perbedaan berdasarkan gender, serta mengidentifikasi indikator DM yang paling berpengaruh. Penelitian ini melibatkan 300 siswa kelas sepuluh di Sulawesi Selatan, Indonesia, dengan desain kuantitatif ex-post facto. Instrumen penelitian meliputi tes kemampuan pemecahan masalah matematika dan angket disposisi matematis. Data dianalisis menggunakan statistik deskriptif dan inferensial. Hasil menunjukkan 77.6% siswa berada dalam kategori rendah pada DM, sementara 71.0% menunjukkan tingkat MPS yang serupa. DM memberikan kontribusi signifikan terhadap MPS (59.5%), dengan indikator 'apresiasi terhadap nilai matematika' memberikan kontribusi terbesar (0.293). Terdapat perbedaan signifikan pada DM berdasarkan gender, namun tidak pada MPS. Temuan ini menyoroti pentingnya strategi pengajaran yang inovatif dan berbeda yang memprioritaskan peningkatan MD siswa. Strategi semacam itu sangat penting untuk mendorong pendidikan matematika yang inklusif, responsif, dan berorientasi pada kesetaraan, sebuah komitmen yang harus ditegakkan oleh para pendidik dan pembuat kebijakan secara aktif.

INTRODUCTION

Imagine a world without mathematical problem-solving. It's a fundamental aspect of the teaching and learning process in mathematics, requiring *the application* of mathematical concepts to find solutions (Nalurita et al., 2019). These problems can be classified into two categories: routine problems, which can be solved using procedures or steps previously learned, and non-routine problems, which demand new strategies as they cannot be solved using known methods (Mairing, 2020)

The Mathematical Problem-Solving Ability (MPSA) is a crucial concept in mathematics education. It refers to an individual's capacity to apply mathematical knowledge, skills, and understanding to solve problems in unfamiliar contexts (Kantowski, 1977; Liljedahl et al., 2016; Firmansyah & Syarifah, 2023). Pólya & Szegö, (1945) introduced a four-stage MPSA framework: understanding the problem, devising a plan, implementing the plan, and reflecting. This framework, further developed by Schoenfeld (1985), underscores the role of metacognition in MPSA. Metacognition, the awareness and understanding of one's own thought processes, is a crucial element that enhances learning and understanding in mathematical problem-solving.

MPSA is a crucial skill for students as it fosters the development of critical and analytical thinking, which is essential for solving complex problems across various life and work domains. For instance, in a professional setting, MPSA can be used to analyze data and make informed decisions. Additionally, MPSA enhances the ability to adapt to changes and challenges in a dynamic global environment while equipping students with the necessary skills to thrive in careers within the digital era and knowledge-based economy (Okolie et al., 2021). The importance of this ability is increasingly emphasized by the need for students to face the ever-changing challenges of the future.

However, several studies indicate that students' MPSA remains relatively low, and this is a matter of urgent concern. The 2022 Programme for International Student Assessment (PISA) results placed Indonesia at rank 68 with a mathematics score of 379. Tampa et al. (2022) found that the MPSA of 8th-grade junior high school students needed to be higher, regardless of the school's status or accreditation level. The Trends in International Mathematics and Science Study (TIMSS) survey also reported that the average mathematics score of Indonesian students was below the international average (TIMSS, 2019). Other studies have shown that low MPSA is found across all levels and stages of education (Gunawan et al., 2023).

One significant factor influencing students' MPSA is Mathematical Disposition (MD). Katz (2009), Yani and Ningsih (2019), and Atallah et al. (2010) stated that MD is closely related to attitudes, beliefs, and tendencies that encourage positive thinking and effort in learning mathematics. Meanwhile, Royster et al. (1999), Depi et al. (2022), and Fairus et al. (2023) described MD as deliberate actions frequently performed during mathematics learning. (NCTM, 2000, 2014; Biber et al., 2013) expanded MD into seven key indicators: self-efficacy, flexibility of thinking, persistence, curiosity, metacognition, mathematical connections, and appreciation of mathematical values. These seven indicators work complementarily to support the development of students' MPSA.

Self-efficacy in mathematics enables students to believe in their ability to complete tasks, making them more persistent even when faced with difficulties. Research indicates self-efficacy strongly correlates with MPSA (Zakariya, 2022; Chytrý et al., 2020). Flexibility of thinking allows students to select the best approach for solving problems based on specific contexts, which has also been proven to enhance MPSA (Magalhães et al., 2020; de Santana et al., 2022).

Persistent students strive to understand problems, try different approaches, and correct errors. This perseverance is crucial for solving complex mathematical problems (Xiao & Sun, 2021; Scherer & Gustafsson, 2015). Furthermore, curiosity drives students to explore new ideas and discover creative solutions to problems (Peterson & Cohen, 2019; Jaen & Baccay, 2016).

Mathematical connections and appreciation of mathematical values also play a significant role. Students who can link mathematical concepts to real-life situations better understand the relevance of their knowledge (Artstein et al., 2014; Jawad, 2022). Meanwhile, an appreciation of mathematical values motivates students to comprehend and apply mathematical concepts in practical contexts (Chen et al., 2018; Hutajulu et al., 2019).

Previous studies on the relationship between mathematical disposition and Mathematical Problem Solving Ability (MPSA) have been conducted by many experts. Jacobbe et al. (2012) and Hoon et al. (2021) found that mathematical disposition has a significant influence on MPSA and on increasing engagement in mathematics learning. Gökçe & Güner (2024), revealed that students with good mathematical disposition are more actively engaged in exploratory learning and are better prepared for challenging mathematical tasks. However, these studies only highlighted the global relationship between mathematical disposition and *MPSA*, without examining the specific contribution of each mathematical disposition indicator, such as self-efficacy, flexibility of thinking, perseverance, and others to MPSA. It is important to address this gap because each mathematical disposition indicator has a different role in supporting MPSA. Understanding the specific contribution of each indicator is crucial as it will provide more targeted guidance for educators, allowing them to strengthen those aspects of mathematical disposition that need extra attention. To fill this literature gap, one of the objectives of this study is to explore the contribution of each mathematical disposition indicator to students' MPSA.

In addition, gender differences in mathematics education have long been a focus of research (Barrow-Green et al., 2019). Differences in cognitive, psychological and learning style preferences between males and females influence how they process information and solve mathematical problems (Mašic et al., 2020). For example, females tend to prefer the Converger learning style, which emphasizes comprehension and practical application, while males often prefer the Assimilator learning style, which focuses on abstract conceptualization and reflective observation (Awofala et al., 2020)

In addition, differences in brain activation have also been found to contribute to students' approach to mathematics. Males are more dominant in abstract reasoning, while females excel in detail processing and working memory (Hill et al., 2014; Ganley & Vasilyeva, 2014). Psychological factors, such as higher math anxiety in females, also affect their self-efficacy (Wang et al., 2020).

Various studies have confirmed this difference. Fennema and Sherman (1977) and Keller (2020) found a gender gap in MPSA. Other studies have shown differences in math performance and approaches between male and female students. However, these differences are often contextual (Liu, 2009; Mashuri & Yawan, 2023).

Regarding mathematical disposition, (Casad et al., 2017) found significant differences between male and female students, which were mainly influenced by gender stereotypes in mathematics. Meanwhile, (Recber et al., 2018) found that gender plays an important role in shaping mathematical dispositions, especially through the dimensions of self-efficacy, anxiety, and attitude toward mathematics.

Although gender differences in the context of dispositions and mathematical problem-solving ability have been widely researched, this study still examines gender aspects as a complementary goal. This is important to (1) enrich the understanding of the role of gender in the specific contribution of mathematical disposition indicators on the MPSA, (2) expand the geographical scope of similar research, and (3) provide more contextualized insights into the mathematics education setting in Indonesia.

Based on the above literature review and to achieve the stated research objectives, this study was designed to systematically answer a series of interrelated questions. The questions were systematically structured, from exploring students' basic ability levels to analyzing the relationships between variables and gender differences. Research hypotheses were developed based on previous empirical findings to test the relationships between variables and gender differences. Specifically, this article addresses the following research questions: (1) What is the MPSA level of tenth grade high school students? (2) What is the MPSA level of tenth grade high school students? (3) Does MD have a significant influence on students' MPSA? (4) Does each indicator of MD significantly influence students' MPSA? (5) Which MD indicator has the most significant influence on students' MPSA? (6) Is there a significant difference in the MD of male and female students? (7) Is there a significant difference in MPSA of male and female students?

The findings from this study regarding the relationship between MD (including the specific contributions of its seven indicators), MPSA, and gender differences are expected to provide an empirical foundation for developing more effective and gender-responsive mathematics learning strategies.

In developing an instrument to measure mathematical disposition, this study refers to the indicators proposed by the National Council of Teachers of Mathematics (NCTM, 2000, 2014), namely: (1) mathematical self-efficacy; (2) mathematical flexibility of thinking; (3) mathematical persistence; (4) mathematical curiosity and creativity; (5) mathematical

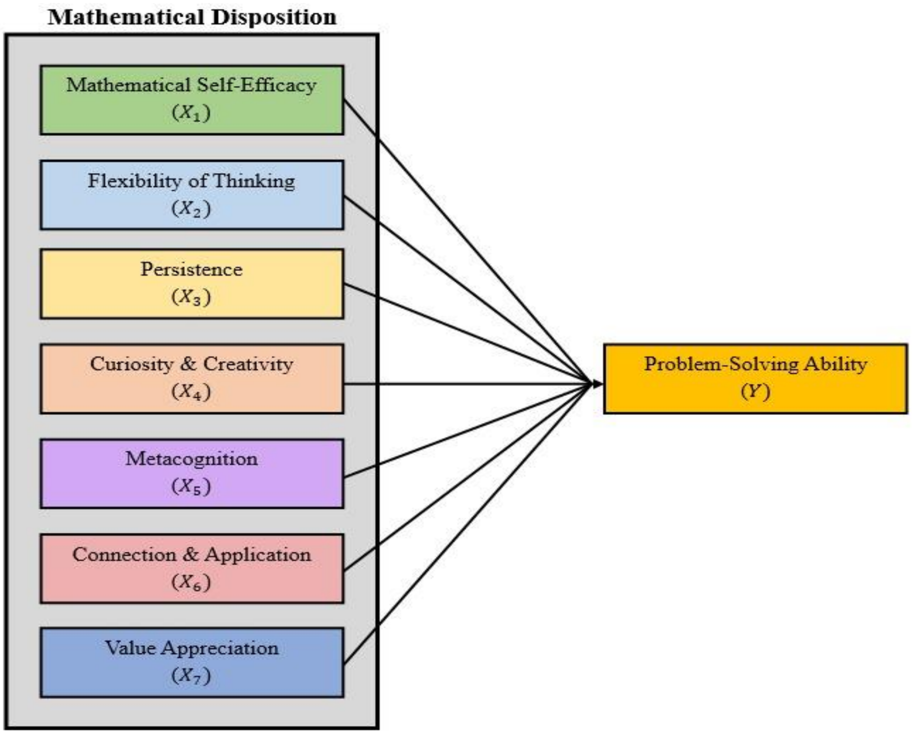

Figure 1. Research Design Study

metacognition; (6) mathematical connections and applications; (7) mathematical value appreciation. Appreciation of the value of mathematics.

METHOD

Research Type and Design

This study utilizes an ex post facto research design, a non-experimental approach widely employed in education and social science research. The ex post facto research design is appropriate for investigating phenomena that have already occurred and cannot be manipulated by the researcher (Coe et al., 2021). This method allows us to examine the relationship between mathematical problem-solving ability, mathematical disposition, and gender. Furthermore, the ex post facto design allows for the examination of several variables simultaneously, which is particularly important for our research as we investigate the complex interactions between mathematical problem-solving ability, various indicators of mathematical disposition, and gender. This comprehensive approach provides a deeper understanding of the factors influencing mathematics performance and attitudes among secondary school students. The research design is shown in Figure 1.

From Figure 1, (1) The **Independent variable (Mathematical Disposition)** is comprised of seven indicators. This variable is quantified through the administration of a questionnaire, which aims to ascertain its impact on students' capacity to solve problems; (2) **Dependent variable (Problem-solving Ability)**. This variable is quantified through the administration of a mathematics problem-solving assessment; (3) **Moderator Variable (Gender).** This variable is employed to ascertain whether there are notable discrepancies in mathematical disposition and problem-solving proficiency—furthermore, gender functions as a moderating variable that influences the relationship between mathematical disposition and problem-solving ability.

The research stages included the

following: (1) The requisite ethical and official permits have been obtained; (2) the research sample of 300 students using the Purposive Stratified Cluster Random Sampling technique has been determined; (3) the research instrument, comprising a mathematics disposition questionnaire and a mathematics problem-solving ability test, has been validated by experts and tested. The results demonstrated the validity and reliability of the research. The research hypothesis was established, the data was collected, the statistical methods used to analyze the data, including descriptive statistics, inferential statistics (multiple regression and t-test), and the statistical software employed (SPSS), was determined, the results of the statistical analysis were interpreted, and the results were reported.

Research Subject

This study was conducted in South Sulawesi, Indonesia, comprising twenty-one districts and three cities. The study encompassed six educational institutions, three within the city and three outside. The research sample was established using the purposive stratified cluster random sampling technique. The sampling process was structured as follows: (1) The initial step involved identifying an odd-semester high school class of students in the 10th grade. The rationale for this decision is that the 10th grade is a transitional period between junior high school and high school, and thus, the findings of this study may be indicative of the junior high school level; (2) South Sulawesi's senior high schools (SMA) were stratified based on geographical location (city and outside the city); (3) schools were grouped into clusters based on district/city area. Three districts were randomly selected from the twenty-one districts in the region, and three cities were retained as separate clusters; (4) from each selected cluster (three districts and three cities), one school was randomly selected, resulting in six schools being selected; (5) from the six selected schools, 50 students each were randomly selected, including 25 boys and 25 girls, resulting in a total of 300 students, consisting of 150 boys and 150 girls. The profile of the research subjects is presented in Table 1.

Table 1. Profile of Quantitative Research Subjects

Location	School Status	Accreditation	Number of subjects	Number of Subjects by gender	
				M	F
A1 City	State	A	50	25	25
A2 City	Private	A	50	25	25
A3 City	Private	B	50	25	25
B1 district	State	B	50	25	25
B2 district	State	A	50	25	25
B3 District	State	C	50	25	25
Total number of subjects			300	150	150

Research Instruments

The present study employed two instruments: the MDQ (Mathematical Disposition Questionnaire) and the Mathematics Problem Solving Ability Test. The MDQ was developed by the NCTM indicators (2000, 2014). Each indicator is comprised of six statement items, three of which are favorable and three of which are unfavorable. Thus, the total number of items is 42. The questionnaire is a Likert scale, with gradations from strongly disagree to strongly agree. The response options were "strongly disagree," "disagree," "agree," and "strongly agree." Five experts validated the questionnaire using a validation sheet. The results of the expert assessment demonstrated a Content Validity Ratio (CVR) = 100%, indicating that the questionnaire measures what it is intended to measure. The questionnaire was then tested on 57 students, and the results showed a Cronbach's Alpha = 0.75, indicating good internal consistency. This means that the items in the questionnaire are highly correlated, suggesting that the MDQ is a valid and reliable instrument.

The instrument for the Mathematics Problem Solving Ability Test was adapted from the PISA problem, consisting of four context problems. One problem concerns number pattern (exhibition context), one problem concerns systems of linear equations (shopping context), one problem concerns elevation angles (eruption mountain context), and one problem concerns reading statistical graphs (business context). The test was validated by five experts with a Content Validity Ratio (CVR) = 100%. Additionally, the test exhibited reliability, as evidenced by a Cronbach's Alpha = 0.72, based on the results obtained from 57 students. This indicates that the problem-solving ability test exhibits satisfactory validity and reliability. Moreover, each instrument is accompanied by a scoring rubric and defined categories.

Instrument, scoring rubric, and categories are presented in the link below: https://drive.google.com/file/d/1d_sH0JFgobO0olVjB2DLA5DfPn70p_l1/view?usp=sharing

Data Collection and Analysis

The data were collected from a diverse and inclusive sample of 300 high school students in the 10th grade, with an equal number of male and female students (150 males and 150 females). This diversity ensures that the study's findings represent both genders and a broad population. The study employed the mathematics problem-solving ability test and the mathematics disposition questionnaire (MDQ) as research instruments. Quantitative data analysis was conducted using statistical software, employing various analytical techniques. First, descriptive statistics were employed to characterize the extent

Table 2. Descriptive statistics for Mathematical Problem-Solving Ability (MPSA)

Question number	Score Interval, Frequency, and percentage										Data centering measure		
	85≤X≤100		70≤X<85		55≤X<70		40≤X<55		0≤X<40				
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Mean	SD	Max
All questions	0	0	14	4.7	73	24.3	132	44.0	81	27.0	47.1	12.9	78.1
Questions- 1	21	7.0	48	16.0	89	29.7	99	33.0	43	14.3	57.3	15.5	87.5
Questions- 2	6	2.0	29	9.7	85	28.3	100	33.3	80	26.7	51.8	15.0	87.5
Questions- 3	0	0.0	13	4.3	69	23.0	115	38.3	103	34.3	46.3	13.8	75.0
questions -4	0	0.0	0	0.0	17	5.7	59	19.7	224	74.7	33.1	13.3	68.8

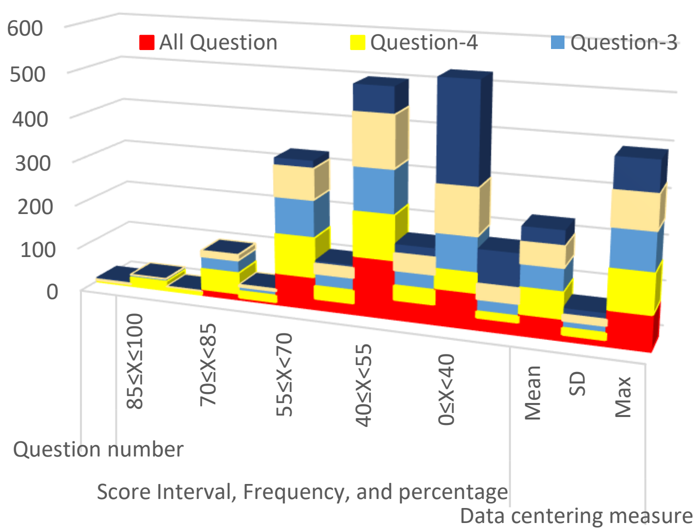

Figure 2. Visualization of mathematical problem-solving (MPSA) test scores

of students' problem-solving abilities and mathema-tical dispositions. Subsequently, an independent t-test was employed to ascertain the discrepancies between male and female students concerning their mathematical disposition and problem-solving abilities. Moreover, a multiple regression analysis was performed to investigate the influence of mathematical disposition on mathematical problem-solving ability.

RESULT AND DISCUSSION

Result

Descriptive Findings

A descriptive analysis was conducted to gain insight into the data distribution characteristics of each variable under study. This entailed calculating measures of central tendency, including the mean and median, as well as measures of variability, such as the standard deviation and range. These calculations were performed on data about mathematics problem-solving test scores and mathematics disposition scores, with comparisons by gender also included.

Table 2 presents the descriptive statistics for the mathematical problem-solving ability (MPSA) test scores. Table 3 presents the descriptive statistics for mathematical disposition (MD) scores. Table 4 The following Table 2, 3, 4 present the descriptive statistics for MPSA and MD test scores by gender.

As shown in Table 2 and Figure 2, the mean score of students' MPSA falls into the low category, with a mean score of 47.1 and a standard deviation of 12.9. The distribution of scores reveals that most students (71%) were in the 'Low' or 'Very Low' category, with 44.0% in the 'Low' category and 27.0% in the 'Very Low' category. Only 4.7% of students achieved the 'High' category, and no

Table 3. Descriptive Statistics for Mathematical Disposition (MD) scores

	Score Interval, Frequency, and percentage										Data centering measure		
	$85 \le X \le 100$		$70 \le X < 85$		$55 \le X < 70$		$40 \le X < 55$		$25 \le X < 40$				
Indicator	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Mean	SD	Max
All	0	0.0	0	0.0	67	22.3	226	75.3	7	2.3	51.1	5.3	38.1
X1	6	2.0	233	77.7	43	14.3	18	6.0	0	0.0	72.7	8.6	87.5
X2	0	0.0	0	0.0	23	7.7	129	43.0	148	49.3	52.4	6.5	66.7
X3	0	0	0	0	93	31	207	69	0	0	43.5	8.0	66.7
X4	0	0.0	0	0.0	13	4.3	168	56.0	119	39.7	43.5	8.0	66.7
X5	0	0.0	0	0.0	0	0.0	73	24.3	227	75.7	36.0	4.6	50.0
X6	0	0.0	3	1.0	29	9.7	246	82.0	22	7.3	48.2	7.4	75.0
X7	0	0.0	121	40.3	89	29.7	90	30.0	0	0.0	63.8	10.7	83.3

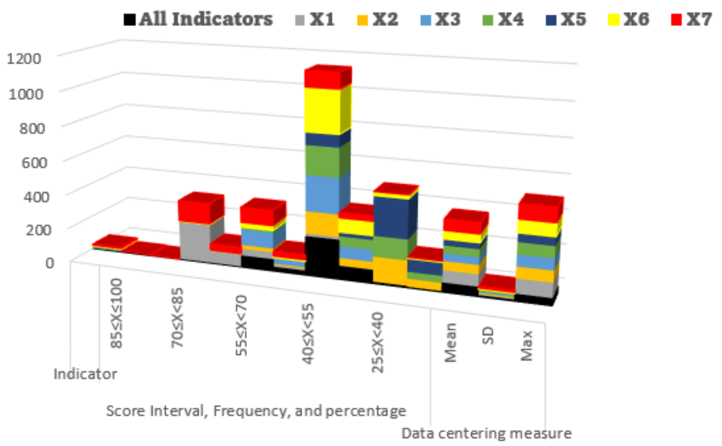

Figure 3. Visualization of mathematics disposition (MD) scores

students reached the 'Very High' category. This assessment is a crucial tool in understanding student performance and identifying areas for improvement.

Upon closer examination, it's clear that students need help across all MPSA items. However, one item stands out-item number 4, which involves reading statistical graphs. Students showed significant difficulties with this item, as indicated by an average score of only 33.1, with 74.7% of students falling into the 'deficient' category.

Table 3 and Figure 3 illustrate that students' mathematical disposition (MD) is within the low category. This is indicated by the mean score of 51.1 with a standard deviation 5.3. Most students (75.3%) were classified within the "Low" category, while 22.3% were placed within the "Medium" category. No students demonstrated a level of mathematical disposition (MD) that could be classified as "high" or "very high."

Further analysis of MD indicators revealed that students exhibited low MD and demonstrated deficient levels of the following indicators: mathematical metacognition, the flexibility of mathematical thinking, mathematical persistence, mathematical curiosity and creativity, and mathematical connections and applications.

As illustrated in Table 4 and Figure 4, our study has found a marked gender-based gap in problem-solving ability among students. The mean score of females (48.2) was higher than the mean score of males (46.2), indicating a descriptive difference. In addition, the proportion of female students in the highest category (5.3%) was more significant than that of male students in the same category (4%). Similarly, the mathematical disposition of

Table 4. Descriptive Statistics for MPSA and MD test scores by Gender

Variable	Gender	Score Interval, Frequency, and percentage										Data centering measure	
		85≤X≤100		70≤X<85		55≤X<70		40≤X<55		0≤X<40*)			
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Mean	SD
MPSA	M	0	0.0	6	4.0	34	22.7	67	44.7	43	28.7	46.0	12.2
	F	0	0.0	8	5.3	39	26.0	65	43.3	38	25.3	48.2	12.9
MD	M	0	0.0	0	0.0	38	19.3	110	77.3	2	3.3	50.4	5.3
	F	0	0.0	0	0.0	38	25.3	110	73.3	2	1.3	51.7	5.2

*) for MD score (25≤X<40)

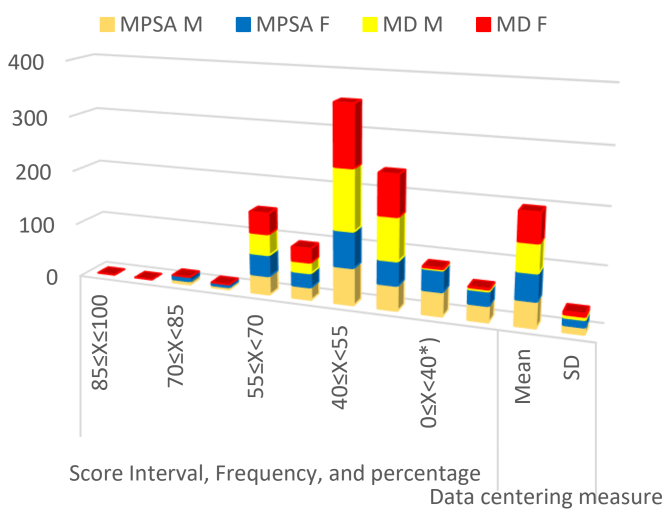

Figure 4. Visualization of MPSA and MD test scores by gender

male and female students also showed descriptive differences. The mean score for female students (51.7) was higher than that of male students (50.4), and the proportion of female students in the moderate category (25.3%) was higher than that of male students in the high category (19.3%). These key findings underscore the impact of our research in understanding and addressing gender disparities in education.

Inferential Findings

Before employing multiple regression, a comprehensive series of prerequisite tests are conducted. These tests cover a range of factors including normality, heteroscedasticity, and multicollinearity, ensuring a thorough and robust analysis (Alita et al., 2021; Williams et al., 2019).

Table 5 displays the outcomes of the multiple linear regression prerequisite tests. These tests are based on the relationship between the dependent variable, mathematical problem-solving ability (Y), and the independent variable, mathematical disposition (X), which is a composite of seven key indicators. These indicators, each with its own significant contribution, are crucial in understanding problem-solving ability and are as follows:

X1: mathematical self-efficacy; X2: mathematical flexibility of thinking; X3: mathematical persistence; X4: mathematical curiosity and creativity; X5: mathematical metacognition; X6: Mathematical connection and application; X7: Mathematical value appreciation.

Table 5. Multiple Linear Regression prerequisite test results

Statistical Test	Variable							
	Y	X1	X2	X3	X4	X5	X6	X7
S1	0.57	0.61	0.59	0.63	0.58	0.64	0.56	0.54
S2	0.114	0.883	0.997	0.124	0.328	0.075	0.117	0.124
S3	1.451	1.608	1.269	2.345	1.857	2.806	2.148	1.451

S1: Normality (Kolmogorov-Smirnov; S2: Heteroscedasticity (sig.); S3: Multicollinearity (tolerance)

Table 5 demonstrates that the data for all variables are normally distributed (sig. value > 0.05). Additionally, the data exhibit no indications of heteroscedasticity (sig. value > 0.05). Furthermore, no multicollinearity symptoms exist in any of the variables (Tolerance value > 0.10). Therefore, the prerequisites for employing multiple linear regression have been satisfied.

The results of the multiple regression calculations, conducted using the statistical software SPSS, are presented in Tables 6 and 7.

Table 6. Summary of Multiple Linear Regression Models and Analysis of Variance (ANOVA)

Aspects	Results
Model Sumarry	R = 0.598, R^2 = 0.595, Adjusted R^2 = 0.595
ANOVA	F = 8492.173, Sig. = 0.000

Table 7. Regression Coefficient of Mathematical Disposition (MD) Indicator

Variable	Coefficient (B)	Std. Error	Beta	t	Sig.
(Constant)	-75.521	0.604	-	-125.026	0.000
X1	0.358	0.007	0.237	48.089	0.000
X2	0.325	0.009	0.189	36.436	0.000
X3	0.341	0.009	0.172	37.307	0.000
X4	0.399	0.010	0.246	39.260	0.000
X5	0.273	0.016	0.097	17.451	0.000
X6	0.326	0.012	0.186	27.102	0.000
X7	0.354	0.007	0.293	48.903	0.000

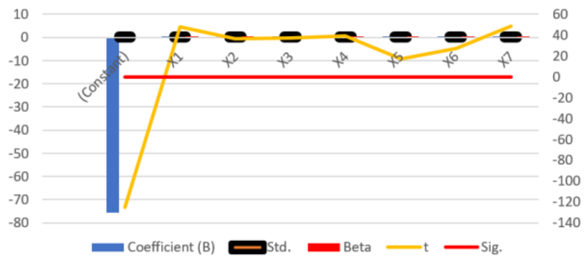

Figure 5. Visualization of regression coefficients

As illustrated in Tables 6 and 7 and Figure 5, the regression model demonstrates a high level of predictive capacity, as evidenced by an R^2 value of 0.595. This suggests that 59.5% of students' mathematical problem-solving proficiency variability can be attributed to the seven indicators of mathematical disposition examined. Moreover, the ANOVA test yielded an F-value = 8492.173 with a p-value < 0.05, indicating that the regression model is statistically significant in predicting students' mathematical problem-solving ability. Moreover, the significance value of 0.000 for all indicators indicates that all indicators of mathematical disposition positively and significantly impact students' mathematical problem-solving ability.

The standardized beta coefficient values indicate that the order of the contribution of the mathematical disposition indicators, from largest to smallest, is as follows: mathematical value appreciation demonstrates the most significant contribution, followed by mathematical curiosity, creativity, and mathematical self-efficacy. Moreover, mathematical flexibility of thinking is associated with a value marginally higher than that of mathematical connections and applications. Mathematical persistence is sixth, while mathematical metacognition shows the most minor contribution but remains significant.

The results demonstrate that each indicator of mathematical disposition plays a substantial role in students' mathematical problem-solving abilities, with notable variations in its influence. Notwithstanding the discrepancies in the beta coefficient values, all indicators exhibited a substantial positive correlation with the dependent variable.

MPSA and MD by Gender

This section is dedicated to a research question of profound significance: Do gender-based differences exist in problem-solving ability and mathematical disposition? This question, with its potential to inform and shape our understanding of cognitive disparities, is the cornerstone of our study.

The independent sample t-test will be employed to ascertain whether the mean difference between the two groups (male and female) is statistically significant.

Before embarking on the independent sample t-test, we meticulously conducted normality and homogeneity tests, as recommended by Alita et al. (2021) and Williams et al. (2019). These tests, presented in table 8, were performed using the robust statistical software program SPSS, ensuring the reliability of our results.

Table 8. Prerequisite Test Results of independent sample t-test

	Normality Test (Kolmogorov-Smirnov)		Homogeneity test (sig.)	
Variables	P	W	Based on Mean	Based on Median
MPSA	0.082	0.285	0.659	0.652
MD	0.065	0.96	822	0.817

As illustrated in Table 8, the data exhibits a normal distribution and is homogeneous, enabling the application of the independent sample t-test to assess the research hypothesis. The results of the independent sample t-test, as calculated in SPSS, are presented in Table 9.

Table 9. Hasil Uji Independent Sample T-Test MPSA dan MD Berdasarkan Gender

Variables	t	df	Sig. (2-tailed)	Mean Difference
MPSA	-1.504	298	0.134	-2.2393
MD	-2.125	298	0.034	-1.2980

Table 9 indicates no statistically significant difference in problem-solving ability between male and female students. The value of Sig evidence this. (2-tailed) = 0.134 > 0.05. Conversely, the mathematical disposition between male and female students is significantly different. This is demonstrated by the Sig value (2-tailed) = 0.034 < 0.05.

Discussion

This study explored the relationship between Mathematical Problem Solving Ability (MPSA), Mathematical Disposition (MD), and Gender among grade 10 students in South Sulawesi, Indonesia. Overall, the findings indicate that students' MPSA and MD levels are in the low category, in line with the research results of Attami et al. (2020), Zhang et al. (2023), and Tampa et al. (2022). Similar phenomena have been identified across different geographical contexts by Zhang et al. (2023), indicating that this challenge is global in mathematics education. In addition, this study confirmed the positive influence of MD on MPSA, which emphasizes the important role of mathematical disposition in mathematics learning. These findings reinforce previous research by Hutajulu and Hidayat (2023), Pajares and Miller (1995), and Busnawir et al. (2023), which highlighted the important role of MD in improving problem-solving ability. The discussion focuses on two interesting findings for deeper analysis:

Gender Paradox in MD and MPSA

The study revealed an interesting phenomenon where no gender differences were found in MPSA, yet there were significant differences in MD. This paradox can be explained through several critical perspectives.

First, the absence of gender differences in MPSA could be attributed to the compensatory mechanisms adopted by students. Research shows that students with lower MD often develop compensatory strategies such as seeking peer support, dedicating additional study time, or consulting teachers to overcome their deficiencies (Fredricks et al., 2018). These strategies allow students to achieve comparable levels of MPSA performance despite differences in MD. Research by Borgonovi et al. (2023) showed that female students are more likely to seek peer help, while male students prefer individual exploration when facing math problems. These approaches yielded comparable results despite differences in learning styles.

Secondly, contextual factors such as gender equality-based education reforms also contribute to creating a more inclusive learning environment. Contemporary teaching methods, such as problem-based and collaborative learning, allow students from different ability backgrounds to contribute effectively to the learning process (Nurjanah et al., 2019). These approaches accommodate different learning styles, whether based on abstract reasoning or observational learning, thus reducing the negative impact of the MD gap on MPSA outcomes.

Third, reducing gender stereotypes in mathematics education has increased female students' engagement in problem-solving activities. Teachers who are more aware of the importance of gender equity often provide equal encouragement to both male and female students, fostering a classroom atmosphere that supports active participation from all students (Casad et al., 2017). This demonstrates that while gender differences in mathematical disposition exist, social support and equitable learning environments can mitigate their impact on academic outcomes.

Fourth, the adaptability of modern assessment systems has also contributed to the equalization of MPSA outcomes. These systems, which focus on results and the problem-solving process, creativity, and diverse solution approaches (Taylor et al., 2024), can accommodate various problem-solving styles, which may differ between genders. This adaptability offers equal opportunities for all students to demonstrate their abilities, reassuring the audience about the fairness of the evaluation process.

Fifth, the role of educational technology in modern mathematics education has helped bridge the gap in mathematical disposition between genders. Digital learning platforms and technological tools provide various means to understand and solve mathematical problems, enabling students to choose approaches that best suit their learning styles (Abidin et al., 2018). Research indicates that female students are more comfortable with visual-interactive approaches, whereas male students tend to focus on mathematical abstraction. This helps balance differences in mathematical disposition and ensures equal access to learning resources.

Sixth, this study also suggests that differences in mathematical disposition may reflect self-perception and socio-cultural factors rather than actual problem-solving abilities. Longitudinal studies indicate that gender differences in mathematical disposition are often shaped by societal expectations and cultural stereotypes (Chan, 2022). However, both genders can demonstrate equivalent problem-solving skills when given appropriate opportunities and support.

The Dominance of Appreciation for Mathematics Grades: Analyzing Its Relationship with the MPSA

The significant shift from the traditional emphasis on mathematics self-efficacy to the importance of 'appreciation of mathematics value' as the strongest predictor of the MPSA is an important finding. This contrasts with previous research, such as that conducted by Krawitz & Schukajlow (2018). This underscores the need for a deeper analysis of the role of mathematics value appreciation in mathematics learning, particularly in relation to the MPSA.

Appreciation of the value of mathematics plays an important role in fostering stable intrinsic motivation. Unlike self-efficacy, which is often situational and fluctuates, value appreciation provides stronger and longer-term motivation. When students understand the relevance of math in real life, they not only show greater resilience in the face of mathematical challenges, but also develop a deeper appreciation for the subject. This intrinsic motivation encourages students to delve deeper into abstract concepts and to seek conceptual understanding rather than procedural knowledge (Rodríguez et al., 2021). For example, students who have a high appreciation of the value of mathematics tend to view math as an important tool for solving real-world problems, which ultimately increases their perseverance in learning.

Understanding the long-term relevance of mathematics is not just a matter of perception, but also has a significant influence on students' cognitive processes. Those who appreciate the practical importance of mathematics are better able to connect abstract concepts with real-world applications, such as using geometry in architectural design or statistics in data analysis (Hohol & Miłkowski, 2019). This knowledge transfer process is particularly important in problem solving, where students must integrate theory with concrete situations that demand cognitive flexibility. Research shows that students with a high appreciation of the value of mathematics are more adept at identifying patterns, formulating strategies, and applying appropriate approaches to solving mathematical problems (Matthews, 2018).

Moreover, appreciation of the value of mathematics is not only a theoretical concept, but also a practical tool that helps students to maintain perseverance when facing obstacles. Students who have a positive view of the relevance of mathematics are more likely to try different strategies to find solutions and reflect on their mistakes rather than giving up when facing difficulties. This perseverance allows them to achieve better results, even in consistently complex problems (Barnes, 2019). In this regard, appreciation of the value of mathematics provides a practical framework that supports students continued cognitive exploration.

Unlike dispositional indicators, such as self-efficacy or cognitive flexibility, value appreciation forms the motivational foundation that drives exploration and sustains learning. While self-efficacy is critical for building students' confidence to try, without an appreciation of mathematical values, this motivation may not be sufficient to encourage deep exploration or complex problem solving (Voica et al., 2020). In contrast, combining a high appreciation of the value of mathematics with moderate self-efficacy results in optimal problem-solving performance, as evidenced by recent research (Du et al., 2021).

This multi-perspective analysis underscores the potential of pedagogical interventions to bridge the gap between mathematical disposition and problem-solving ability based on gender. It offers hope for the future of gender equity in education, showing that with the right interventions and systemic support, the gap can be effectively bridged.

Implications of Research

The findings from this study make significant contributions to various aspects of mathematics education.

For educational practitioners, the results of this study highlight the importance of teachers developing learning strategies that focus on problem solving skills and actively foster positive mathematical dispositions. One potential strategy is local context-based differentiated instruction, which helps students learn mathematics meaningfully by connecting it to real-life experiences. In addition, teachers should also utilize *assessment for learning* and *assessment as learning to* provide richer feedback. Diverse assessment methods, such as portfolios and performance-based assessments, can be used to support more holistic learning.

At the policy level, this research underscores the need for professional development programs, including training to design differentiated learning tools and adaptive technologies. Such technologies include digital learning platforms that enable personalization of materials and evaluation. This support will assist teachers in designing innovative and student-centered teaching, while improving the overall quality of learning.

Limitations

This study has some limitations that must be acknowledged. Methodologically, the ex-post facto design limits the ability to draw causal inferences between MD and MPSA variables. Potential biases in the research instruments, particularly in measuring MD, should also be considered. The external validity of the findings is limited by the sample being confined to one region, and the influence of socio-cultural factors on the reliability of MD measurement has not been fully controlled.

The context of the study also has limitations, such as not including variables such as socioeconomic status, teaching quality, and learning environment. The influence of culture on MD and the role of parental and community support have not been explored in depth. In addition, this study did not analyze the interaction between gender, social status and culture in MPSA.

Future research directions include a more in-depth exploration of the interactions between gender, MD and MPSA and the development of models that integrate contextual factors. Longitudinal studies are needed to understand the development of MD and the mechanism of the MD-MPSA relationship. Experimental approaches can be used to test the effectiveness of specific interventions, while cross-cultural and geographical studies can extend the generalizability of findings.

Practical applications include testing the effectiveness of instructional strategies differentiated instructional strategies based on local contexts in improving MD and MPSA. Technology-based intervention programs, such as adaptive digital platforms, should be validated to ensure personalized learning supports MD development. Research on the application of gender-responsive learning strategies in various local contexts is an important step to ensure alignment with students' needs.

CONCLUSIONS

This study found a significant relationship between mathematical disposition and mathematical problem-solving ability based on gender among grade 10 students in South Sulawesi, Indonesia. The main findings showed that most students showed low levels of problem-solving ability and mathematical disposition. All indicators of mathematical disposition were found to significantly influence problem-solving ability, with appreciation of the value of mathematics identified as the largest contributor. While there was no significant difference in problem-solving ability between male and female students, a significant difference was seen in their mathematical disposition. These findings underscore the importance of developing learning strategies that prioritize improving problem-solving ability and fostering positive mathematical dispositions, considering gender differences. The findings of this study not only provide a solid foundation for developing a more comprehensive and responsive approach to mathematics education and open new avenues for future research in this area.

REFERENCES

Abidin, Z., Mathrani, A., & Hunter, R. (2018). Gender-related differences in the use of technology in mathematics classrooms: Student participation, learning strategies and attitudes. The International Journal of Information and Learning Technology, 35(4), 266–284. https://doi.org/10.1108/IJILT-11-2017-0109

Alita, D., Putra, A. D., & Darwis, D. (2021). Analysis of classic assumption test and multiple linear regression coefficient test for employee structural office recommendation. *IJCCS (Indonesian Journal of Computing and Cybernetics Systems)*, 15(3), 295–306.

Artstein, Z., Borwein, J., van der Poorten, A., Shallit, J., Zudilin, W., Franklin, J., Joshi, N., & Prince, G. (2014). *Mathematics and the Real World*. Prometheus Books NY.

Atallah, F., Bryant, S. L., & Dada, R. (2010). *Learners' and teachers' conceptions and dispositions of mathematics from a Middle Eastern perspective.* US-China Education Review, 7(8), 43–49.

Attami, D., Budiyono, & Indriati, D. (2020). Mathematical resilience and mathematical problemsolving ability in Junior High School. *Journal of Physics: Conference Series*, *1613*(1), 012028. https://doi.org/10.1088/1742-6596/1613/1/012028

Awofala, A. O., Lawal, R. F., & Arigbabu, A. A. (2020). Future teachers' mathematics cognitive failures and their learning styles. *International Journal on Teaching and Learning Mathematics*, *3*(1), 12-22

Barnes, A. (2019). Perseverance in mathematical reasoning: The role of children's conative focus in the productive interplay between cognition and affect. *Research in Mathematics Education*, *21*(3), 271–294.

Biber, A. C., Tuna, A., & Incikabi, L. (2013). An investigation of critical thinking dispositions of mathematics teacher candidates. *Educational Research*, *4*(2), 2141– 5161.

Borgonovi, F., Han, S. W., & Greiff, S. (2023). Gender differences in collaborative problem-solving skills in a cross-country perspective. *Journal of Educational Psychology*, 115(5), 747-766. https://doi.org/10.1037/edu0000788

Busnawir, B., Mukhsar, M., Ahmad, H., & Kodirun, K. (2023). Measurement of Mathematical Problem Solving Ability Based on Self Efficacy Categorization Using Mixed Methods Approach. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(2), 2238-2252. https://doi.org/10.24127/ajpm.v12i2.7212.

Casad, B. J., Hale, P., & Wachs, F. L. (2017). Stereotype threat among girls: Differences by gender identity and math education context. *Psychology of Women Quarterly*, 41(4), 513–529.

Chan, R. C. (2022). A social cognitive perspective on gender disparities in self-efficacy, interest, and aspirations in science, technology, engineering, and mathematics (STEM): The influence of cultural and gender norms. *International Journal of STEM Education*, *9*(1), 1–13. https://doi.org/10.1186/s40594-022-00352-0

Chen, L., Bae, S. R., Battista, C., Qin, S., Chen, T., Evans, T. M., & Menon, V. (2018). Positive attitude toward math supports early academic success: Behavioral evidence and neurocognitive mechanisms. *Psychological Science*, *29*(3), 390–402. https://doi.org/10.1177/0956797617735528

Chytrý, V., Medová, J., Říčan, J., & Škoda, J. (2020). Relation between pupils' mathematical self-efficacy and mathematical problem solving in the context of the teachers' preferred pedagogies. *Sustainability*, 12(23), 10215, 22 pages. https://doi.org/10.3390/su122310215

Coe, R., Waring, M., Hedges, L., & Day Ashley, L. (Eds.) (2021). *Research Methods and Methodologies in Education. (3 ed.)* SAGE Publications.

de Santana, A. N., Roazzi, A., & Nobre, A. P. M. C. (2022). The relationship between cognitive flexibility and mathematical performance in children: A meta-analysis. *Trends in Neuroscience and Education*, *28*, 100179. https://doi.org/10.1016/j.tine.2022.100179

Depi, S., Suendarti, M., & Liberna, H. (2022). Pengaruh Disposisi Matematika dan Kecerdasan Logika Matematika Terhadap Kemampuan Pemecahan Masalah Matematika. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *6*(3), 525–537. http://jurnal.ugj.ac.id/index.php/JNPM/article/view/6981

Du, C., Qin, K., Wang, Y., & Xin, T. (2021). Mathematics interest, anxiety, self-efficacy and achievement: Examining reciprocal relations. *Learning and Individual Differences*, *91*, 102060. https://doi.org/10.1016/j.lindif.2021.102060

Fairus, F., Fauzi, A., & Sitompul, P. (2023). Analisis Kemampuan Disposisi Matematis pada Pembelajaran Matematika Siswa SMKN 2 Langsa. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *7*(3), 2382-2390.

Fennema, E., & Sherman, J. (1977). Sex-Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors. *American Educational Research Journal*, 14, 51-71. https://doi.org/10.3102/00028312014001051.

Firmansyah, M., & Syarifah, L. (2023). Mathematical Problem Solving Ability in View of Learning Styles. *Prima: Jurnal Pendidikan Matematika, 7(1), 58-66.* https://doi.org/10.31000/prima.v7i1.7217.

Fredricks, J. A., Hofkens, T., Wang, M., Mortenson, E., & Scott, P. (2018). Supporting girls' and boys' engagement in math and science learning: A mixed methods study. *Journal of Research in Science Teaching*, 55(2), 271–298. https://doi.org/10.1002/tea.21419

Ganley, C. M., & Vasilyeva, M. (2014). The role of anxiety and working memory in gender differences in mathematics. *Journal of Educational Psychology*, *106*(1), 105-120. https://doi.org/10.1037/a0034099

Gökçe, S., & Güner, P. (2024). Pathways from cognitive flexibility to academic achievement: Mediating roles of critical thinking disposition and mathematics anxiety. *Current Psychology*, 43(20), 18192–18206. https://doi.org/10.1007/s12144-024-05642-0

Gunawan, R., Mudjiran, M., Suherman, S., Yerizon, Y., Musdi, E., Armiati, A., & Rozika, E. (2023). An Analysis of Mathematical Problem-Solving Skills of Junior High School Students. *Indonesian Journal of Science and Mathematics Education, 6(3), 351-365.*

Hill, A. C., Laird, A. R., & Robinson, J. L. (2014). Gender differences in working memory networks: A BrainMap meta-analysis. *Biological Psychology*, 102, 18–29. https://doi.org/10.1016/j.biopsycho.2014.06.008

Hohol, M., & Miłkowski, M. (2019). Cognitive artifacts for geometric reasoning. *Foundations of Science*, *24*(4), 657–680. https://doi.org/10.1007/s10699-019-09603-w

Hoon, T., Singh, P., Adnan, M., & Choo, K. (2021). Students' Reflections on Dispositions in a Mathematics Classroom, *Journal of ASIAN Behavioural Studies*, *6*(18), 61-78. https://doi.org/10.21834/JABS.V6I18.384.

Hutajulu, M., Wijaya, T., & Hidayat, W. (2019). The Effect of Mathematical Disposition and Learning Motivation on Problem Solving: An Analysis. *Infinity Journal*, *8*(2), 229-238. https://doi.org/10.22460/infinity.v8i2.p229-238.

International Association for the Evaluation of Educational Achievement (IEA). (2023). *TIMSS 2023 assessment frameworks*. Amsterdam: IEA. Retrieved from https://timssandpirls.bc.edu/timss2023/frameworks/index.html

Jacobbe, T., Ross, D. D., & Hensberry, K. K. R. (2012). The effects of a family math night on preservice teachers' perceptions of parental involvement. *Urban Education*, *47*(6), 1160–1182. https://doi.org/10.1177/0042085912447805.

Jaen, M. C. A., & Baccay, E. S. (2016). Curiosity, Motivation, Attitude, Gender, and Mathematics Performance. *The Normal Lights*, *10*(2), 89-103. https://doi.org/10.56278/tnl.v10i2.255

Jawad, L. F. (2022). Mathematical connection skills and their relationship with productive thinking among secondary school students. *Periodicals of Engineering and Natural Sciences* (PEN), 10(1), 421-430. https://doi.org/10.21533/pen.v10i1.2667

Kantowski, M. (1977). Processes Involved in Mathematical Problem Solving. *Journal for Research in Mathematics Education*, *8*, 163-180. https://doi.org/10.5951/JRESEMATHEDUC.8.3.0163.

Katz, L. G. 2009. Disposition as Educational Goals. (Online). Retrieved from http://www.edpsycinteractive.org/files/edoutcomes.html, Accessed at 5 July 2024.

Keller, L., Preckel, F., Eccles, J., & Brunner, M. (2020). Top-Performing Math Students in 82 Countries: An Integrative Data Analysis of Gender Differences in Achievement, Achievement Profiles, and Achievement Motivation. *Journal of Educational Psychology*, *114*(5), 966. https://doi.org/10.31234/osf.io/73wap.

Krawitz, J., & Schukajlow, S. (2018). Do Students Value Modelling Problems, and are They Confident They Can Solve Such Problems? Value And Self-Efficacy for Modelling, Word, and Intra-Mathematical Problems. *Zdm*, *50*, 143–157. https://doi.org/10.1007/s11858-017-0893-1

Liljedahl, P., Santos-Trigo, M., Malaspina, U., & Bruder, R. (2016). *Problem Solving in Mathematics Education.* Springer Nature. https://doi.org/10.1007/978-3-319-40730-2.

Liu, O. (2009). An Investigation of Factors Affecting Gender Differences in Standardized Math Performance: Results from U.S. and Hong Kong 15 Year Olds. *International Journal of Testing*, 9, 215-237. https://doi.org/10.1080/15305050903106875.

M. Hutajulu, T. T. Wijaya, and W. Hidayat. (2019). The effect of mathematical disposition and learning motivation on problem solving: an analysis'. *Infinity Journal*, *8*(2), 229–238.

Magalhães, S., Carneiro, L., Limpo, T., & Filipe, M. (2020). Executive functions predict literacy and mathematics achievements: The unique contribution of cognitive flexibility in grades 2, 4, and 6. *Child Neuropsychology*, *26*(7), 934–952. https://doi.org/10.1080/09297049.2020.1740188

Mairing, J. P. (2020). Mathematical problem-solving behaviors of the routine solver. *International Journal of Education*, 13(2), 105–112. https://doi.org/10.17509/ije.v13i2.23276

Mashuri, S., & Yawan, H. (2023). Gender Difference Influence Students' Performance in Learning Math in Secondary Schools. *International Journal Of Education, Social Studies, And Management (IJESSM), 3(1), 1-12*. https://doi.org/10.52121/ijessm.v3i1.114.

Mašic, A., Polz, E., & Becirovic, S. (2020). The Relationship between Learning Styles, GPA, School Level and Gender. *European Researcher, 11 (1), 51–60*.

Matthews, J. S. (2018). When am I ever going to use this in the real world? Cognitive flexibility and urban adolescents' negotiation of the value of mathematics. *Journal of Educational Psychology*, *110*(5), 726. https://doi.org/10.1037/edu0000242

Nalurita, B. R., Nurcahyono, A., Walid, W., & Wardono, W. (2019). Optimalisasi Pemecahan Masalah Matematis pada Pembelajaran Problem Based Learning (PBL) Berbantuan E-Comic Math. *PRISMA, Prosiding Seminar Nasional Matematika*, *2*, 395-402.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: NCTM.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: Author.

Nurjanah, N., Suryadi, A., Abdulhaq, I., & Budimansyah, D. (2019). Gender-sensitive effect of problem-based learning on student performance in Indonesian teacher college classes. *The New Educational Review*, 55, 54–63. https://doi.org/10.15804/tner.2019.55.1.04

Okolie, U., Igwe, P., Mong, I., Nwosu, H., Kanu, C., & Ojemuyide, C. (2021). Enhancing students' critical thinking skills through engagement with innovative pedagogical practices in Global South. *Higher Education Research & Development*, 41, 1184-1198.

https://doi.org/10.1080/07294360.2021.1896482.

Pajares, F., & Miller, M. (1995). Mathematics self-efficacy and mathematics performances: The need for specificity of assessment. *Journal of Counseling Psychology, 42*, 190-198. https://doi.org/10.1037/0022-0167.42.2.190.

Peterson, E. G., & Cohen, J. (2019). A case for domain-specific curiosity in mathematics. *Educational Psychology Review, 31*(4), 807–832. https://doi.org/10.1007/s10648-019-09501-

Polya, G. (1945). *How to solve it; a new aspect of mathematical method.* Princeton University Press.

Recber, S., Isiksal, M., & Koç, Y. (2018). Investigating self-efficacy, anxiety, attitudes and mathematics achievement regarding gender and school type. *Anales de Psicología/Annals of Psychology*, *34*(1), 41–51. https://doi.org/10.6018/analesps.34.1.229571

Rodríguez, S., Estévez, I., Piñeiro, I., Valle, A., Vieites, T., & Regueiro, B. (2021). Perceived competence and intrinsic motivation in mathematics: Exploring latent profiles. *Sustainability*, *13*(16), 8707. https://doi.org/10.3390/su13168707

Royster, D., Harris, M., & Schoeps, N. (1999). Dispositions of College Mathematics Students. *International Journal of Mathematical Education in Science and Technology*, 30, 317-333. https://doi.org/10.1080/002073999287851.

Scherer, R., & Gustafsson, J.-E. (2015). The relations among openness, perseverance, and performance in creative problem solving: A substantive-methodological approach. *Thinking Skills and Creativity*, *18*, 4–17. https://doi.org/10.1016/j.tsc.2015.04.004

Schoenfeld, A. H. (1985). Making sense of "out loud" problem-solving protocols. *The Journal of Mathematical Behavior*, 4(2), 171–191.

T, A. Y., & Ningsih, K. (2019). Character Education Strengthening of Students Through The Mathematical Disposition Strategy on Statistics Elementary. 1–5.

Tampa, A., Layly, S., Helmi, H., & Alimuddin, N. F. (2022). The Students' Numerical Literacy Ability in Junior High Schools. *Kreano, Jurnal Matematika Kreatif-Inovatif, 13*(2), 269–282.

Taylor, C. L., Said-Metwaly, S., Camarda, A., & Barbot, B. (2024). Gender differences and variability in creative ability: A systematic review and meta-analysis of the greater male variability hypothesis in creativity. *Journal of Personality and Social Psychology, 126*(6), 1161. https://doi.org/10.1037/pspp0000484

TIMSS. (2019). *TIMSS 2019 International Results in Mathematics and Science.* International Association for the Evaluation of Educational Achievement (IEA). Retrieved from https://timss2019.org/reports/achievement/index.html

Voica, C., Singer, F. M., & Stan, E. (2020). How are motivation and self-efficacy interacting in problem-solving and problem-posing? *Educational Studies in Mathematics, 105*(3), 487–517. https://doi.org/10.1007/s10649-020-10005-0

Wang, Z., Rimfeld, K., Shakeshaft, N., Schofield, K., & Malanchini, M. (2020). The longitudinal role of mathematics anxiety in mathematics development: Issues of gender differences and domain-specificity. *Journal of Adolescence*, *80*, 220–232. https://doi.org/10.1016/j.adolescence.2020.03.003

Williams, M. N., Grajales, C. A. G., & Kurkiewicz, D. (2019). Assumptions of multiple regression: Correcting two misconceptions. *Practical Assessment, Research, and Evaluation*, 18(1), 11, 16 pages.

Xiao, F., & Sun, L. (2021). Students' motivation and affection profiles and their relation to mathematics achievement, persistence, and behaviors. *Frontiers in Psychology*, *11*, 533593. https://doi.org/10.3389/fpsyg.2020.533593

Zakariya, Y. F. (2022). Improving students' mathematics self-efficacy: A systematic review of intervention studies. *Frontiers in Psychology*, 13, 986622. https://doi.org/10.3389/fpsyg.2022.986622

Zhang, Q., Guo, J., & Wei, Y. (2023). Mathematical dispositions among Hong Kong mathematics pre-service teachers: A metaphor-based exploration. *Asian Education and Development Studies, 12*(2/3), 221–235.