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Mathematics-Anxiety and Self-Efficacy of Junior High School Students: Is There a Gender Gap?

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Abstract

Several studies have attempted to investigate the influence of gender differences on aspects of mathematics-anxiety (MA) and self-efficacy (SE) at various levels of education. However, exploration focusing on junior high school students is still limited, so it is important to understand how these dynamics develop at that level of education. Therefore, to overcome the gap, this study aims to investigate the influence of gender differences on MA and SE junior high school students. The type of research used is quantitative research with a comparative causal method. The population is all students in grades VII, VIII, and IX in one of the private junior high schools in Central Java. The sample of this study is 79 students, consisting of 39 male students and 40 female students. The sampling technique is stratified random sampling with strata based on grade level (VII, VIII, IX). The data collection technique used a questionnaire about MA and SE. Data analysis techniques using Hotelling's T^2 to test the significance of the differences in MA and SE aspects based on gender simultaneously and the Independent Sample T-test to test the significance of gender differences in each variable separately. Hotelling's T^2 test showed a significant influence of gender differences on MA and SE simultaneously. The Independent Sample T-test found that the female group was more anxious than the male and there was no significant difference in their SE. Therefore, it can be concluded that there is a gender gap in MA, but not in SE.

Keywords: Mathematics-Anxiety, Self-Efficacy, Gender, Hotelling's T^2, Independent Sample T-test

Introduction

Some experts say that mathematics is a science that studies structures, patterns, relationships, and changes using abstract concepts such as numbers, spaces, and functions (Chihara, 2003; Higham et al., 2015). Kaminski et al. (2008) said that mathematics is a science that studies abstract work objects. In addition, Sumardyono (2004) argues that mathematics is also often seen as a tool to solve daily problems. Finally, Skrandies and Klein (2015) defines mathematics as a science that relies on brain activity. Based on these four definitions of mathematics, a common thread can be drawn that mathematics is a science that studies abstract work objects, including structures, patterns, and relationships that are highly dependent on brain activity, so that it becomes a tool to solve problems in daily life. In the context of mathematics education, mathematics not only serves as a tool to solve problems in various disciplines and technologies but also as a medium to develop critical, analytical, logical, and creative thinking skills (NCTM, 2000). Because the object of mathematics work is abstract, not a few students experience difficulties in participating in mathematics learning in class (Hamdunah et al., 2016; Putriani & Rahayu, 2018; Abidin & Retnawati, 2019).

Especially in mathematics learning in junior high school, mathematics is often considered a complex subject because of its abstract, logical, systematic, and filled with symbols and complex formulas (Brahier, 2020). This view makes students develop negative perceptions of mathematics, such as the notion that mathematics is scary (Sartika & Yulita, 2019; Jaltare & Moghe, 2020), not important (Sartika & Yulita, 2019), difficult and boring (Wijaya et al., 2020; Rebollo et al., 2022), abstract (Mutlu, 2019), and full of formulas (Fauzy & Nurfauziah, 2021). To overcome this negative response, various factors need to be considered in mathematics learning, including the willingness, ability, and intelligence of students, teacher and student readiness, curriculum, and appropriate presentation methods (Lusiana et al., 2022). Motivation or willingness must continue to be nurtured in students because this significantly affects their interest in mathematics (Mabruri et al., 2019; Ponidi et al., 2020). Students who are less interested in mathematics tend to have difficulty understanding the material presented, which leads to low learning achievement (Hussein & Csíkos, 2023; Pathuddin et al., 2025; Retnowati et al., 2017; Suren & Ali Kandemir, 2020). Negative responses to mathematics also have an impact on the low quality of education, as seen from the results or learning achievements of students in mathematics (Aguilar, 2021; Boadu & Boateng, 2024). Based on this, one of the main factors that reduce learning achievement is mathematics-anxiety.

Mathematics-anxiety (MA) is one of the affective factors that interfere with academic achievement in mathematics (Widjajanti et al., 2020; Lailiyah et al., 2021). MA refers to a kind of fear, tension, and anxiety experienced by some people when dealing with mathematics (Mutodi & Ngirande, 2014). Students who experience MA may feel worried or disgusted with mathematics (Ramirez et al., 2016). In other words, MA is a feeling of discomfort that arises when facing a math problem (Ramirez et al., 2016). The effects that arise when anxiety arises are feelings of panic, hopelessness, paralysis, and mental disorganization that arise (Lyons & Beilock, 2012). Anxiety can also disrupt a person's mental structure and make them hate math (Ramirez et al., 2016). Students who are very anxious about mathematics have negative feelings when engaging in mathematics, which interferes with their performance (Peker, 2009). Yaftian & Barghamadi (2022) revealed that MA is found in students from primary to higher education. Luttenberger et al. (2018) also revealed that in the 2012 assessment of the Programme for International Student Assessment (PISA) from 34 countries, as many as 59% of students aged 15 to 16 reported that they were often worried about learning math in class, 33% reported that they were very nervous when they had to complete math homework, and another 31% stated that they were very nervous when working on math problems.

Further, MA can be understood as increased physiological anxiety and reactivity when individuals are confronted with mathematics, such as when they have to manipulate numbers, solve mathematical problems, or face mathematical-related evaluative situations (Luttenberger et al., 2018). Based on this, according to Nolen-Hoeksema et al. (2007), there are four types of anxiety symptoms. The four symptoms of anxiety include: (a) Somatic, which is anxiety symptoms related to conscious movement, including goosebumps, tense muscles, increased heart rate, irregular breathing, shortness of breath, dilated pupils, increased stomach acid, decreased saliva, and so on; (b) Emotional, namely symptoms of anxiety related to emotions, including fear, terror, restlessness, and irritability; (c) Cognitive, which is anxiety symptoms related to cognitive factors, including anticipation of danger, impaired concentration, worry, pension, loss of control, fear of death, and unrealistic thinking; and (d) Behavior, including:

running away, avoiding math-related situations, and other actions that show rejection or avoidance of math tasks. Overall, MA can lead to a negative cycle where discomfort and inability to do math can exacerbate anxiety, leading to academic difficulties. It creates a "vicious circle" where MA hinders students from understanding the material, reducing self-confidence and motivation.

Studies show that MA not only affects students in general but also shows that there are significant differences between females and males. Some studies indicate that females often report higher levels of MA than males. For example, research conducted by Erdem (2017) and Mutodi & Ngirande (2014) revealed a significant difference in MA based on gender, with females tending to experience higher levels of MA than males, which can affect their achievement and attitudes towards the subject. In contrast to the study, several other studies showed different results. For example, Wahid et al. (2014) and Devine et al. (2012) note that there is no significant gender difference in MA between females and males. These findings suggest that gender differences in MA may be influenced by the specific context of each study or other factors that have not yet been fully identified. Anxiety when learning mathematics can be overcome in various ways. One way to address this is by increasing students' self-efficacy.

Self-efficacy (SE) is confidence in one's ability to organize a task to achieve a particular result (Bandura, 1997). SE influences how individuals set goals, choose tasks, and overcome obstacles, as well as contribute to the achievement of successful outcomes (Bandura, 2017). In addition, Schunk (1989) also defines SE as a person's belief regarding their ability to succeed in academic tasks. This indicates that SE influences academic motivation and achievement by determining how much effort is expended, resistance to adversity, and response to failure (Schunk & Pajares, 2022). Therefore, SE will have an effect on a person's behavior. The higher a person's SE, the more likely the expected results will be achieved (Hocevar et al., 2014). SE utilizes a level of self-control in dealing with any anxiety and difficulties that arise (Luberto et al., 2014). SE is considered very important as an internal factor that encourages students to excel and influences students' choices in learning activities. Students with high SE are generally diligent and do not give up easily when faced with failure or difficulties (Santrock, 2009). Research shows that SE is not only influenced by internal factors such as individual beliefs but also by external factors, including gender (Huang, 2013).

Bandura (1997) suggests that females and males may experience differences in SE due to different social and cultural influences. Gender roles and stereotypes can influence how individuals develop and nurture their SE. For example, a study conducted by Busch (1995) revealed that there was no significant gender difference in computer learning. On the other hand, Buchanan & Selmon (2008) in their research, there is a significant gender difference in the SE of students. Other research reveals that interventions aimed at improving SE can help reduce gender gaps in various academic fields (Isaac et al., 2012; Rusli, 2017). Strategies such as cooperative learning, positive role models, and emotional support are effective in improving SE and helping to address the gap.

Several previous studies have attempted to investigate the influence of gender differences in MA and SE. Some of these studies were conducted by: (1) Morán-Soto & González-Peña (2022), who investigated the MA and SE levels of engineering students; (2) Gabriel et al. (2019), who investigated the MA and SE levels of health students; (3) Sevgi & Arslan (2020), who investigated the MA and SE levels of high school students in Kayseri, and Xie et al.

(2019), who investigates MA and SE high school students in China. However, some of these studies have not explicitly investigated MA and SE students at the junior high school level. In other words, further research in this context is still limited. In fact, the junior high school period is a critical transition period in students' academic and psychological development. Research is urgently needed, focusing on MA and SE students at the junior high school level. Therefore, to overcome the gap, the study offers novelty in investigating the influence of gender differences on MA and SE students in junior high school. The findings of this study are expected to help design more effective interventions, adjust teaching approaches, and support education policies that are more inclusive and responsive to gender differences. Based on previous research findings, the facts show that learning design significantly influences students' MA and SE, especially when the design considers gender-related factors (Almasri, 2022; El-Emadi et al., 2019; Mizala et al., 2015). By identifying how gender differences influence MA and SE, this research can help teachers better understand how students feel when they practice and perform mathematics-related activities and what types of strategies can be designed to reduce anxiety and increase self-efficacy, so improving teaching methods and support provided to students.

Based on the description above, the research question that arises is whether gender differences significantly influence MA and SE junior high school students? Therefore, this study aims to investigate this question.

Methods

Research Design

The research method used is quantitative with a comparative causal approach. This approach was chosen because the study aimed to investigate the influence of gender differences on MA and SE among junior high school students by comparing pre-existing differences between naturally formed groups, namely male and female students. As stated by Gay et al. (2012), causal comparative approach aims to identify the causes or reasons for observed differences in group characteristics, where the independent variable (gender) is believed to influence the dependent variables (MA and SE). Based on this, the design of this study can be seen in Table 1.

Table 1
Research Design

Variable	Variable Name	Variable Type	Measurement Scale
Independent	Gender (male and female)	Categorical	Nominal
Dependent	Mathematics-Anxiety	Quantitative	Interval
	Self-Efficacy	Quantitative	Interval

Participant

The population in this study is all students in one of the private junior high schools in Central Java, totaling 120 students. The research sample comprised 79 students, with 39 male students (49.37%) and 40 female students (50.63%). The sampling technique used is stratified random sampling, which is a sampling technique in which the population is divided into sub-groups (strata) based on specific criteria (Koyuncu & Kadilar. 2009). This study used class levels (VII, VIII, IX). The sample was then randomly taken from each stratum, so 25 students from class VII, 27 students from class VIII, and 27 students from class IX were obtained.

Instrument Data

The data collection technique used a questionnaire designed to measure MA and SE. The questionnaire for MA is adapted from the Mathematics Anxiety Scale (MAS) developed by Cooke (2011) with 13 items. Meanwhile, the questionnaire for SE is adapted from an instrument developed by Hackett & Betz (1989) with 12 items. This questionnaire uses a four-point Likert scale: (1) "Strongly disagree," (2) "Disagree," (3) "Agree," and (4) "Strongly agree." Students are asked to answer questions based on their experiences, feelings, and thoughts about mathematics-anxiety and self-efficacy they experience at school.

Validity and Reliability of Data Instruments

After the test instrument is completed, the next stage is the internal validity test. Internal validity includes logical validation. The instrument was validated by two validators who are experts in the field of psychology. The logical validity carried out is construct validity. This aims to ensure that the instruments that have been created are consistent with abstract psychological characteristics (Crocker & Algina, 1986; Payne et al., 2003). The construct's validity is assessed by asking the validator to provide a score. Items considered appropriate or essential are given a score of "1", while items that are not essential are given a score of "0".

Of the 26 items, 25 valid items were obtained based on the results of the validity analysis, with validity criteria determined using the Pearson Product-Moment formula. Validity was determined by comparing the r-count value to the r-table value at a significance level of 5%. An item is declared valid if r-count > r-table and invalid if otherwise. Next, researchers measured the level of reliability using Cronbach's Alpha formula (Cronbach, 1951). Based on the calculation results, the reliability score is 0.77. The score shows that the instrument has high reliability (Arikunto, 2010). The validation sheet instrument was then also analyzed using the content validity ratio (CVR) formula, namely Cohen's Kappa inter-raters (McHugh, 2012). This test is intended to see how strong the level of agreement between the two validators is in validating the validation sheet instrument. This test is intended to see how strong the level of agreement between two validators is in validating the validation sheet instrument. Based on the CVR analysis, a score of 0.86 was obtained, which means that the reliability level of the two validators is considered high (strong agreement).

In addition, external validity was tested through a pilot study to test the instrument on 5 students from a similar population. This pilot study helps identify and correct items that may not function properly or be confusing for respondents, thus strengthening the validity and reliability of the instrument before it is used in primary data collection. The results of the test show that the MA instrument is ambiguous in items number 2 and 6, while in the SE instrument, it is found that item number 4 requires further clarification. These results are the basis for researchers' revisions. The MA questionnaire grid can be seen in Table 2, while the SE questionnaire grid is in Table 3.

Table 2
MA Questionnaire Grid

Indicator	Sub Indicators	Item Statement	Item Number
Somatic	[1] Hands sweat easily excessive [2] Rapid heartbeat	1, 2, 3, 4	4
Cognitive	[1] Difficult feelings concentrate [2] Feelings of worry about what other people think [3] Forgetting something that is usually remembered	5, 6, 7, 8	4
Affective	[1] Restless about lessons in mathematics [2] Afraid about what should be done [3] Not confident	9, 10, 11	3
Mathematical Knowledge	[1] Understanding of mathematics topic [2] Presumption against mathematics ability	12, 13	2
	Total		13

Table 3
SE Questionnaire Grid

Indicator	Sub Indicator	Item Statement	Item Number
Level	Confidence in the level of task difficulty that can be achieved resolved	1, 2, 3, 4	4
Generality	Mastery of a particular field or task	5, 6, 7, 8	4
Strength	The power of belief which are owned	9, 10, 11, 12	4
	Total		12

Data Analysis Techniques

Furthermore, data processing and analysis in the calculation process were carried out using the computer tools of the RStudio program (Posit team, 2023; R Core Team, 2023). Data analysis techniques using Hotteling's T^2. This test is used when it has one predictor variable (independent variable), namely gender, with two categories (male and female) and two dependent variables, MA and SE. Hotteling's T^2 allows researchers to test the relationship between dependent variables at each level of independent variables (Cole et al., 1994). The goal was to test whether there were significant differences between gender groups in the concurrently bound variables. Before conducting the Hotteling's T^2 test, a test was first carried out on each assumption in Hotteling's T^2, namely: (1) The two populations have a normal multivariate distribution and (2) The matrix of population variances is the same or different (Hakstian et al., 1979).

If Hotteling's T^2 test is significant, then the investigation of the influence of gender on each dependent variable, namely MA and SE, using the Independent Sample T-test. This test was chosen because the independent variable, namely gender, consisted of only two categories: male and female. The Independent Sample T-test aims to determine whether there is a significant difference in MA and SE levels between male and female students. Thus, the results of this analysis will identify which gender groups are more anxious and which groups have higher levels of self-efficacy. However, it is important to consider the possibility of type I errors in this analysis. To minimize the risk of type I errors, the researchers used a conservative significance level, setting α = 5%. In addition, Hotteling's T^2 previously conducted also helps reduce the risk of type I errors because it considers the correlation between dependent variables simultaneously before conducting follow-up tests (Moder, 2016). Thus, this analysis's results will provide a more accurate picture of gender differences in MA and SE.

Hypothesis

Several previous studies have revealed that there are significant differences in MA based on gender (Erdem, 2017; Mutodi & Ngirande, 2014). On the other hand, some studies reveal that there are no significant differences in MA based on gender (Devine et al., 2012; Wahid et al., 2014). Furthermore, research on SE also showed similar results, with some studies revealing that there were significant differences in SE by gender (Busch, 1995), while other studies found that there were no significant differences in SE by gender (Buchanan & Selmon, 2008). In this study, the hypothesis proposed by the researcher includes:
H_1 : Gender differences affect MA and SE simultaneously
H_2 : The female group had higher average levels of MA than males
H_3 : The female group had higher average levels of SE than males

To answer H_1, the researchers used Hotteling's T^2 test while H_2 and H_3 used the Independent Sample-test.

Results and Discussion

In this part, the assumptions of Hotteling's T^2 test are tested, followed by the Independent Sample T-test.

Univariate Outlier Detection

Outlier detection uses the boxplot method. Boxplots are a popular and easy method of identifying outliers (Mowbray et al., 2018). There are two categories of outliers: (1) outliers and (2) extreme points.

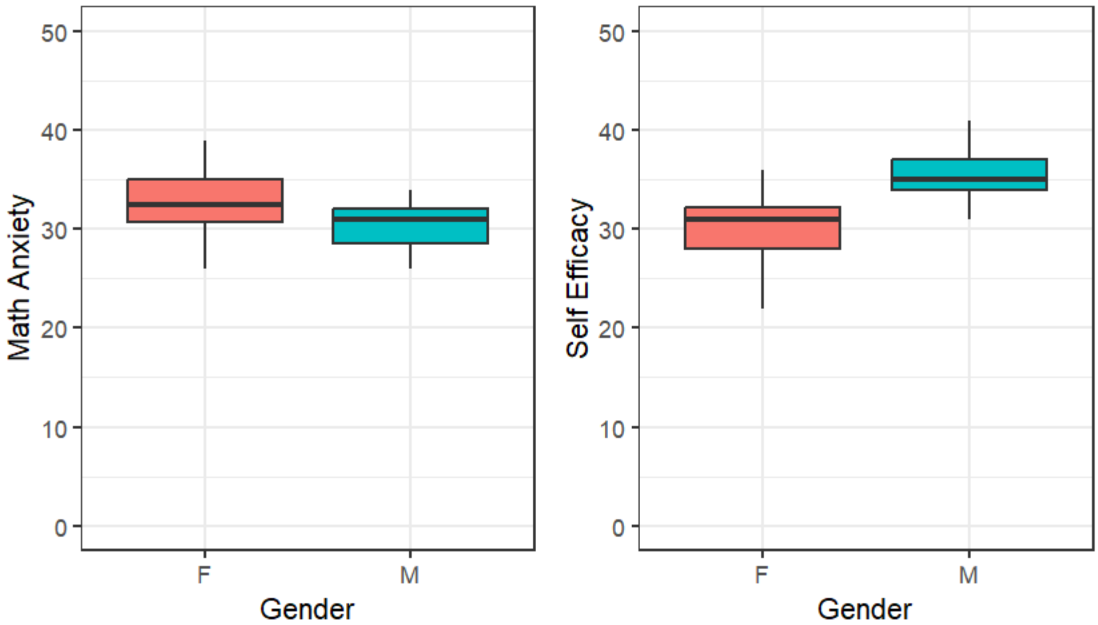

Figure 1. MA and SE Boxplots by Gender

Figure 1 shows the differences between mathematics-anxiety (MA) and self-efficacy (SE) by gender. In the MA, the average score for females (F) appears to be higher than for males (M), which is also reflected in the median position in the boxplot. The length of the lower whisker is larger than the upper whisker for both genders, indicating a distribution that tends to be negatively skewed. In addition, the length of the box for females is larger, indicating that the distribution of MA data is more varied among females. Meanwhile, in SE, the average for males is higher than for females, with the median data for males located above females. The data distribution also tends to be negatively skewed, as seen from the longer lower whisker. The distribution of SE data in females is more varied than in males, as indicated by the larger length of the female's box. There was no indication of univariate outliers in the MA or SE data for both genders.

Multivariate Outlier Detection

Multivariate outliers are data points that have unusual combinations of values on outcome variables (or dependents) (Langford & Lewis, 1998). In multivariate settings, Mahalanobis spacing is generally used to detect multivariate outliers (Leys et al., 2018). This distance helps to determine the observation distance from the center to the cloud, considering the shape of the cloud covariance.

Table 4
Results of Mahalanobis Distance Analysis

Observation	Mahalanobis Distance	p-value	Outlier
1	4.808	0.090	False
2	1.235	0.539	False
3	2.054	0.358	False
4	1.235	0.539	False

5	1.860	0.395	False
6	1.504	0.471	False
7	4.600	0.100	False
8	4.379	0.112	False
9	2.558	0.278	False
10	2.030	0.362	False
11	1.553	0.460	False
12	1.374	0.503	False
13	1.279	0.528	False
14	3.973	0.137	False
15	2.952	0.229	False
16	1.553	0.460	False
17	1.108	0.575	False
18	2.010	0.366	False
19	1.235	0.539	False
20	2.558	0.278	False
21	2.822	0.244	False
22	1.504	0.471	False
23	1.279	0.528	False
24	1.860	0.395	False
25	2.769	0.250	False
26	2.343	0.310	False
27	1.108	0.575	False
28	1.504	0.471	False
29	1.381	0.501	False
30	2.842	0.241	False
31	2.394	0.302	False
32	6.619	0.037	False
33	10.874	0.004	False
34	3.372	0.185	False
35	4.183	0.124	False
36	5.950	0.051	False
37	1.553	0.460	False
38	1.717	0.424	False
39	6.700	0.035	False
40	4.628	0.099	False
41	4.060	0.131	False
42	1.860	0.395	False
43	1.281	0.527	False
44	3.432	0.180	False
45	7.090	0.029	False
46	2.523	0.283	False
47	3.971	0.137	False
48	3.382	0.184	False
49	4.110	0.128	False
50	2.387	0.303	False
51	2.873	0.238	False
52	5.024	0.081	False

53	1.191	0.551	False
54	4.529	0.104	False
55	6.907	0.032	False
56	2.641	0.267	False
57	2.973	0.226	False
58	4.049	0.132	False
59	5.965	0.051	False
60	1.643	0.440	False
61	3.407	0.182	False
62	1.678	0.432	False
63	3.705	0.157	False
64	3.751	0.153	False
65	1.031	0.597	False
66	1.950	0.377	False
67	1.846	0.397	False
68	1.184	0.553	False
69	1.281	0.527	False
70	1.564	0.458	False
71	1.309	0.520	False
72	2.570	0.277	False
73	1.900	0.387	False
74	3.518	0.172	False
75	3.382	0.184	False
76	5.198	0.074	False
77	1.484	0.476	False
78	3.744	0.154	False
79	4.348	0.114	False

The calculated Mahalanobis distance compared to the chi-squared distribution (χ^2) with the degree of freedom equal to the number of dependent variables and the significance level α = 0.001. Based on Table 4, no multivariate outliers were found in the data, assessed by the Mahalanobis distance (p-value > 0.001). No observations deviated significantly from the expected multivariate distribution. Thus, the data used in this analysis can be considered valid without any interference due to outliers that can affect the study's results.

Multivariate Normality Testing

Multivariate normality testing uses the Henze-Zirkler Test (HZ) based on the distance of a non-negative function that measures the distance between two distribution functions (Henze & Zirkler. 1990). In this study, the assumption hypothesis of multivariate normality is H_0: Multivariate normal distributed data and H_1: Multivariate normal undistributed data. The package used in the Rstudio program is "MVN" (Korkmaz et al., 2021).

Table 5
Results of Multivariate Normality Analysis

Group	Independent Variables	Henze-Zikler		
		Statistic	p-value	Multivariate Normality

Female	MA / SE	0.608	0.219	Yes
Male	MA / SE	0.636	0.182	Yes

Based on Table 5, all p-values are > 0.05. This means that both MA and SE variables follow a multivariate normal distribution in each gender.

Linear Relationships Testing with Scatterplot Matrices

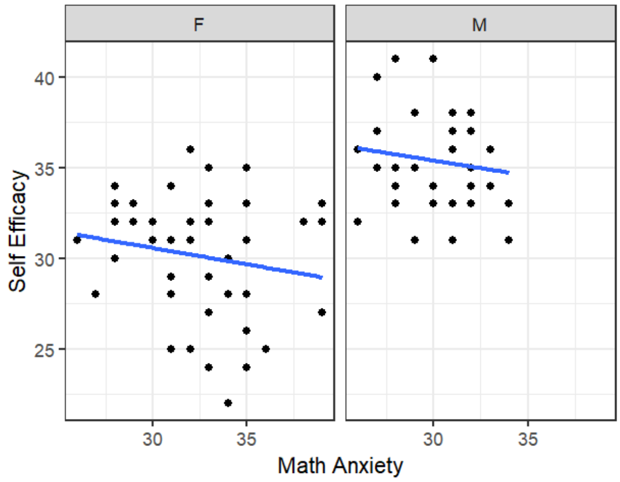

Figure 2. Scatterplot matrix between MA and SE for each gender group

Based on Figure 2, the scatterplot graph shows a negative relationship between MA and SE in female (F) and male (M) students, where the increase in MA tends to be followed by a decrease in SE in both groups.

Homogeneity Testing of the Variance-Covariance Matrix

In this study, the homogeneity testing of the variance-covariance matrix uses the Box-M test. This test aims to test the assumption of covariance matrix similarity between groups in multivariate analysis (Geisser & Greenhouse, 1958). In this study, the hypothesis assumes the homogeneity of the variance-covariance matrix is, for example, 1 (female) and 2 (male). Then $H_0: \Sigma_1 = \Sigma_2$ (the matrix of variance-covariance of both groups is the same) and $H_1: \Sigma_1 \neq \Sigma_2$ (the matrix of variances and covariances of the two groups is not the same). The package used in the Rstudio program is "biotools" (Silva, 2021).

Table 6

Results of Box-M Test Analysis

Chi-Square	df	p-value
5.382	3	0.146

Based on Table 6, the Box's M test statistics are obtained: C = 5.382 and p-value = 0.146 (> 0.05). It can be concluded that the homogeneity assumption of the variance-covariance matrix is met.

Hotteling's T^2 Testing

Table 7

Results of Hotteling's T^2 Test Analysis

T^2	df	p-value
65.584	2	0.000

After ensuring that all assumptions are met, it can be continued with Hotteling's T^2 test to find out whether gender differences have a significant effect on MA and SE simultaneously. The decision criteria are based on the comparison of the calculated T^2 statistical value with the critical value of the distribution χ^2 (chi-square) at the level of significance α = 5% with the degree of freedom according to the number of dependent variables (p = 2). H_0 is rejected if $T^2 > \chi^2_{(0.05;2)}$. Based on Table 7, obtained T^2= 65.584 (> 5.991) with p-value = 0.000. Therefore. It can be concluded that it is H_0 is rejected (H_1 is accepted). This means that gender differences significantly influence MA and SE simultaneously. Furthermore, to find out the magnitude of the influence of gender differences on MA and SE, can use the effect size formula, namely eta-squared (η^2) with package "lsr" (Navarro, 2015). Based on this formula, an effect size of 0.2651 was obtained, so the influence of gender difference interventions was relatively large (see Table 8). It should be noted that the effect-size criteria are based on Abbott (2014) with 0.01 (small), 0.06 (medium), and 0.15 (large). The interpretation of the effect size results showed that 26.51% of the variance in the combination of MA and SE was obtained from gender differences.

Table 8

Results of Effect-Size Analysis

Source	Eta-Square
Gender	η^2 = 0.2651

Because gender differences significantly influence the levels of MA and SE simultaneously, the Independent Sample T-test is continued. This aims to find out which gender groups are more anxious and which groups have higher levels of self-efficacy. However, prerequisite tests were first carried out, namely univariate normality and variance homogeneity tests for MA and SE.

Independent Sample T-test Testing on MA and SE

In this study, a prerequisite test was carried out using univariate normality and homogeneity tests with α = 5%. The hypothesis of univariate normality assumptions are H_0: Normally distributed data and H_1: Data is not distributed normally. The univariate normality test uses the Shapiro-Wilk test, where H_0 is rejected if the p-value < α.

Furthermore, the hypothesis of the homogeneity assumption of variance is H_0: The homogeneity of the variance is the same and H_1: There is at least a pair of heterogeneous variances that are not the same. Homogeneity test using the F where test H_0 is rejected if the p-value < α.

Table 9

Results of Analysis of Gender Group Normality on MA and SE

Independent Variables	Sample Groups	Shapiro-Wilk		
		Statistic	df	p-value
MA	Female	0.968	40	0.309
	Male	0.949	39	0.076
SE	Female	0.947	40	0.059
	Male	0.963	39	0.218

Based on Table 9, the normality prerequisite test was performed using the Shapiro-Wilk test, and the results showed that the p-value for all sample groups > 0.05 (MA Female: 0.309, MA Male: 0.076, SE Female: 0.059, SE Male: 0.218). That is, H_0 is accepted. Thus, data for each sample group's MA and SE variables are normally distributed.

Table 10

Results of Homogeneity Analysis on MA and SE

Independents Variables	F	df	p-value
MA	0.720	77	0.314
SE	0.900	77	0.747

Furthermore, Table 10 shows that the p-values of the sample group for the MA and SE variables are 0.314 and 0.747, both of which are also greater than 0.05 (H_0 is accepted). This shows that the assumption of homogeneity of variance is met. Thus. The MA and SE data analysis process can be continued to the next stage, namely the Independent Sample T-test. This test aims to answer two main questions: (1) whether the female group has a higher average MA level than the male group, and (2) whether the female group has a higher average SE level than the male group. Meanwhile. according to YiXiang et al. (2018) a significant difference can be identified if the p-value < 0.05.

Table 11

Results of the Independent Sample T-test for MA and SE

Condition	t	df	p-value
MA Equal variances assumed	-3.707	77	0.001
SE Equal variances assumed	-7.729	77	0.998

Based on Table 11, a p-value = 0.001 (< 0.05) was obtained for MA. This means that $\boldsymbol{H_0}$ is rejected ($\boldsymbol{H_2}$ is accepted) so that it can be concluded that the female group has a higher average MA level than the male. In other words, females have higher levels of anxiety than males.

Furthermore, p-value = 0.998 (> 0.05) for SE is also obtained. This means that $\boldsymbol{H_0}$ is accepted ($\boldsymbol{H_3}$ is rejected) so that it can be concluded that there is no significant difference in the average SE level between females and males.

The big idea of this study is to investigate the influence of gender differences on MA and SE students in junior high school. Based on $\boldsymbol{T^2}$ statistical test in the first hypothesis, it shows a p-value of 0.000 (< 0.05), so $\boldsymbol{H_0}$ is rejected (see Table 7). This shows a significant difference in the influence of MA and SE simultaneously. The influence of gender differences on MA and SE can be seen from the effect size of 26.51%, so the influence of gender difference interventions is relatively large. These findings highlight the importance of considering gender when developing interventions to address MA and SE in educational settings. The findings of this study are in line with research conducted by several previous researchers (Huang et al., 2019; Morán-Soto & González-Peña, 2022; Rosário & Núñez, 2020). The consequence of these findings is that understanding the factors affecting MA and SE is crucial, especially since these variables significantly impact students' academic performance. A more gender-sensitive math curriculum, which includes different teaching techniques to address MA and improve SE, can be very beneficial (Hasenhütl et al., 2024; Lau & Yuen, 2010). For example, providing additional support and positive feedback for female students as well as creating a learning environment that encourages active participation and the development of self-efficacy (Schunk & Mullen, 2012).

Furthermore, the second hypothesis aims to determine whether the female group has a higher average MA level than males. Based on the Independent Sample T-test test in Table 11, it shows that $\boldsymbol{H_0}$ is rejected ($\boldsymbol{H_2}$ is accepted). Therefore, it can be concluded that the female group is more anxious than males. These findings highlight significant differences in MA levels between females and males. This is in line with research conducted by Erdem (2017) and Mutodi & Ngirande (2014). Although the female group showed higher levels of MA, it is important to note that this difference does not necessarily mean that females are inherently more motivated. These findings support the argument that gender affects MA levels and provide a basis for developing interventions that take gender factors into account. For example, Yu et al. (2024) found that females often feel "helpless" in the face of math tasks, which contributes to higher levels of anxiety than males. Therefore, developing and implementing strategies that can help reduce MA among female students is important. Based on this, Ghasemi Bahraseman et al. (2021), Kassymova et al. (2018), and Shimazu et al. (2006) provide suggestions in the form of the use of stress management techniques, coping skills training, and psychological support in minimizing excessive anxiety.

The third hypothesis tests whether the female group has a higher average SE level than male. Based on the Independent Sample T-test test in Table 11, it shows that $\boldsymbol{H_0}$ is accepted ($\boldsymbol{H_3}$ is rejected). This means there is no significant difference between the two in the SE aspect. Therefore, this suggests that gender factors may not significantly influence students' SE levels. This can be due to the equality of views and goals between females and males in mathematics learning (Egne, 2014). This study's findings align with Busch (1995) and Imro'ah et al. (2019) research. The findings underscore that shifts in attitudes and approaches to education (particularly in mathematics) have created an environment where both genders can thrive equally. However, contrary to the findings in this study, several other studies reported significant gender-based differences in SE. For example, research conducted by Noviani et al. (2023), Mamnoun et al. (2023), and Fathima (2022) showed that female students tend to have higher levels of SE in math tasks compared to male students. In contrast, research conducted by Chen et al. (2021), Moraga-pumarino & Salvo-garrido (2025), and Chan (2022) actually showed that male students had higher levels of SE compared to female students. Differences in cultural contexts, teaching practices, or social expectations in different environments can cause these discrepancies in outcomes. In areas where gender stereotypes are still deeply embedded in educational practices and family parenting, the influence of these social expectations is likely to shape students' attitudes toward mathematics still (Xie & Liu, 2023).

In addition, Hosford & O'Sullivan (2015) said that an inclusive educational environment and support from educators in creating a positive learning atmosphere can contribute to equality at the SE level. Santrock (2009) also supports this view by stating that gender is a social expectation that determines how females and males should think, act, and feel. This reflects a positive change in a more egalitarian educational perspective, which encourages all students to reach their potential without being hindered by the limits set by traditional social norms (Kismiantini & Setiawan, 2024; Kormos & Nijakowska, 2017; Ortan et al., 2021).

Overall, this study shows that gender affects MA levels but does not significantly affect SE levels. This emphasizes the importance of developing and implementing gender-sensitive intervention strategies to reduce MA and support the development of equal SE among female and male students. Gender differences affect the ability to learn mathematics and how mathematical knowledge is acquired. The existence of gender differences in the MA aspect can be caused by several things, such as: (1) Mastery Experiences, where Bandura (1997) said that successful experiences in overcoming mathematical challenges or problems will increase students' self-efficacy; (2) Social Modeling, which according to Bandura (1997) occurs when students see teachers, parents, or peers as models for learning math, and the success of models of the same gender can motivate them to feel capable of achieving similar results; and (3) Social Persuasion, Morelli et al. (2023) and Bandura (1997) said that verbal support from teachers, friends, or family can increase a student's confidence and help them cope with a math task. Conversely, criticism or lack of support can lower their self-efficacy.

These findings have several practical implications for educators and education policymakers. First, it is important to design gender-sensitive curricula and teaching methods. As such, the designed intervention should consider the differences in learning experiences between females and males and provide specific support to address math anxiety in female students. Second, an inclusive and supportive learning environment needs to be continuously improved. Educators must be trained to recognize and address math anxiety in students, create a positive learning environment, and support the development of students' SE regardless of gender. This includes providing positive feedback, additional support, and active learning opportunities.

In addition, the limitations of this study are: (1) a limited sample, this study was conducted on a sample of junior high school students in one specific area. The study's results may not be generalized to the broader population without additional studies covering different regions and types of schools; (2) this study uses a cross-sectional design, which only provides an overview of the relationship between variables at one point in time. Longitudinal studies will be more helpful in observing the changes and developments of MA and SE over time; (3) this study does not fully consider external factors such as family, social, and cultural environment that can also affect MA and SE students. A more comprehensive study that includes these factors can provide a deeper understanding; and (4) although this study highlights the importance of gender-sensitive interventions, it does not evaluate the effectiveness of specific interventions. Therefore, the researchers provide recommendations for future research, such as: (1) conducting research with a broader and more diverse sample to improve the generalization of findings; (2) using a longitudinal design to monitor MA and SE changes over time; (3) consider external factors such as family, social, and cultural environment to obtain a more holistic understanding of the influence of gender on MA and SE; and (4) experimental studies that test different interventions can provide clearer practical insights.

Conclusion

This study aims to investigate the influence of gender differences on MA and SE students in junior high school. Based on Hotelling's T^2 test, it shows that gender differences significantly influence the aspects of MA and SE simultaneously. This is reinforced by the results of the effect size test, which states that the influence of gender is relatively large. Meanwhile, based on the Independent Sample T-test, it was found that the group of female students was more anxious than male. However, the two groups had no significant difference in their self-efficacy. Therefore, it can be concluded that there is a gender gap in MA, but not in SE. From the findings of this study, it can be developed that uses more samples, uses a longitudinal research design, considers a wide range of external factors, and conducts experimental studies with various interventions.

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Appendix. Mathematics-Anxiety and Self-Efficacy Questionnaire

A. Student Information

Name : ………………………………………………………………
Class : ………………………………………………………………
Gender : Male/Female
School : ………………………………………………………………

B. Instructions for Completing the Questionnaire

This questionnaire is intended to collect data on students' levels of mathematics-anxiety (MA) and self-efficacy (SE) in learning mathematics. Please answer each statement honestly and according to your actual condition or feelings. Read each statement carefully, then place a check mark (✓) on the option that best describes your opinion or feeling using the following scale:

SA : Strongly Agree
A : Agree
D : Disagree
SD : Strongly Disagree

C. Note

Your responses to this questionnaire will not affect your academic grade, so please answer each item honestly and sincerely.

D. Questionnaire Statement Items for Mathematics-Anxiety

No.	Statement	Answer			
		SA	A	D	SD
1	I feel nervous about explaining the results of math work in front of the class				
2	I felt trembling in answering the math questions the teacher asked me				
3	I sweat profusely on my palms because I can't do difficult math problems				
4	My heart beat faster during the question and answer session about the material that had been explained				
5	I had a hard time concentrating on facing difficulties during math lessons				
6	I forgot about the material that I already understood in solving math problems				
7	I get frustrated easily in solving high-level math problems				
8	I want math lessons to end quickly				

9	I really avoid the teacher's gaze when students are asked to do math problems				
10	I am afraid that I will not be able to express my opinion in a study group				
11	I am not sure I can do the math problems that need to be solved				
12	I feel like I don't have enough knowledge about math				
13	I only remember the math material when the teacher explained it in class				

E. Questionnaire Statement Items for Self-Efficacy

No.	Statement	Answer			
		SA	A	D	SD
1	I am confident that I can solve complex math problems if I try hard				
2	I am very passionate about solving simple math problems				
3	I feel challenged in completing a high-level math task				
4	I can think of something to do even though I find it difficult to learn maths				
5	I am confident that I can solve math problems well even in new material				
6	I have no difficulty in maintaining and achieving the desired goals				
7	I was able to stay calm in the face of difficulties in learning mathematics.				
8	I am able to be consistent in learning to achieve the expected goals				
9	I have different ways to solve math problems				
10	I am confident that I will be able to solve every math problem given by the teacher because my ability is reliable				
11	I don't give up easily even though I sometimes experience failures				
12	I am ready to face any conditions that occur during mathematics learning				