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Research Article

Affective Factors in Numeracy: Exploring How Math Anxiety and Self-Efficacy Influence Numeracy Skills

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ABSTRACT

This study investigates the relationships between math anxiety, self-efficacy, and numeracy skills among prospective primary school teachers at the State University of Malang. Through quantitative methods, data were gathered from 130 participants using structured questionnaires and numeracy tests. Descriptive statistics and correlation analyses were performed to assess the extent to which math anxiety and self-efficacy influence numeracy performance. The findings reveal weak yet statistically significant correlations, with math anxiety negatively affecting numeracy skills and self-efficacy showing a positive association. However, these variables together accounted for only 3.5% of the variance in numeracy performance, leaving 96.5% of potential predictors unexamined. This suggests that psychological factors like math anxiety and self-efficacy, while important, play a less direct role in shaping numeracy skills than traditionally assumed. The results underline the need for a broader and more integrative approach to understanding the multifaceted nature of mathematical competence. Future studies are encouraged to investigate additional contributing factors, such as cognitive and environmental influences, and to expand the sample size for broader generalization. These findings have implications for designing interventions that simultaneously address psychological and contextual elements to enhance numeracy skills among prospective educators.

Keywords: Math-anxiety; Self-efficacy; Numeracy skills; Affective factors

1. INTRODUCTION

Mathematical ability is one of the most important skills that need to be developed. Not only essential for students, math skills also become a must for the teacher. As a prospective teacher, it is important for a primary school teacher candidate to have good numeracy ability in order to give his or her students an experience of numeracy. This is because numeracy ability plays a crucial role in supporting cognitive development, academic achievement, and informed decision-making across diverse life areas for primary school students (Garcia-Retamero et al., 2019). In the process, surely the attainment and skill in the learning are inseparable from the teacher's role in the process. Teachers who have good numerical abilities are expected to have a positive influence on the development of their students' numerical abilities (Aunio et al., 2021). However, according to studies on numerical abilities in primary school teacher education students, their numerical levels were still low, namely only 29,6% that can achieve the essential numeracy title (Cholifah, et. al., 2020; Nuraini & Humaidi, 2020).

Recent studies highlight the interconnection between numeracy capabilities and essential educational concepts such as critical thinking, system thinking, and self-clarity in mathematical concerns (Gökçe & Güner, 2024). The teaching and learning process can be significantly influenced by anxiety, particularly the perception of mathematics as a frightening subject (Haerudin, et. al, 2021). This phenomenon, known as mathematics anxiety, was first systematically identified by Dreger and Aiken (1957) in their pioneering study of college students, which revealed that a significant proportion of students experienced anxiety related to numerical tasks. Building on this work, Richardson and Suinn (1972) formally defined math anxiety as a feeling of tension or fear that interferes with number manipulation and mathematical problem-solving. Current research confirms that math anxiety remains a significant barrier to mathematical achievement (Skagerlund, et. al, 2024; Ongcoy, et.al, 2023), stemming from both personal factors such as self-awareness and numerical ability, and environmental influences including societal stereotypes (Luttenberger et al., 2018; Khasawneh et al., 2021). The impact of math anxiety extends beyond students to teachers, where primary school teachers' mathematical anxiety can negatively influence their instructional effectiveness and, consequently, their students' mathematical learning progress (Uddin, 2022).

In addition to math anxiety, there is an aspect of self-efficacy that can be a hindrance to or a contributing factor in student mathematics. This is because self-efficacy affects the level of effort, tenacity, and student activity, so good academic achievement is more likely to be obtained by students who have a higher self-efficacy rate (Bandura et al., 1996: Schöber,

et. al, 2018). Bandura's social cognitive theory suggests that self-efficacy, a strong sense of confidence in challenging situations, significantly impacts students' academic performance through various means (Bandura, 1986). Self-efficacy focuses on the component of strong self-confidence in facing situations that are unstable, unpredictable, full of pressure, and (Wangid et al, 2020). People with high self-efficacy will believe that they can do anything to change their surroundings, while people with low self-efficacy fundamentally cannot do anything for their environment. In difficult situations, people with low self-efficacy are more likely to give up, while people with high self-efficacy will try harder to tackle the challenges. Teacher self-efficacy is the belief that they are capable of planning, organizing, implementing, and evaluating learning activities effectively, thereby achieving optimal results in enhancing student competence (Rahayu et al, 2019).

Numeracy Skills

The numeracy skills possessed by students in the study by Asmara & Herwin (2023) were relatively low, indicating that they still lacked understanding of the questions or concepts being asked. Inaccuracy and focus are factors that cause students to solve problems with numeracy skills. This is related to self-efficacy which requires students to focus on solving problems. Belief in the ability to solve all math problems correctly and the feeling of the importance of studying math are dominant factors in influencing self-efficacy in studying math (Hajjina & Retnawati, 2022).

In fact, research suggests that as an individual's math anxiety increases, their belief in their own mathematical capabilities tend to decrease correspondingly (Ruijia, et al., 2022; Cargnelutti, et al., 2017). However, the specific mechanisms underlying how math anxiety, self-efficacy, and numeracy skills are interrelated remains an active area of research interest (Daker, et al., 2023). Numeracy, in this context, refers to the ability to effectively apply mathematical knowledge and skills to real-world situations, enabling individuals to engage with quantitative information and solve practical problems (Zhang, et al., 2019; D'Agostino et al., 2021; Ruijia et al., 2022).

Several research gaps have been identified from the gap analysis of previous studies (Ramirez et al., 2018; D'Agostino et al., 2021; Ruijia et al., 2022; Daker, et al., 2023; Skagerlund, et. al, 2024) investigating the variables of math anxiety and self-efficacy on mathematical ability, including: the need for further investigation into how self-efficacy potentially mediates or moderates the relationship between math anxiety and numeracy skills; a limited comprehension of how the patterns of relationships among these variables; and the advancement of understanding regarding the interactions. Research indicates that primary teachers often have higher math anxiety than other professionals, which can be transmitted to students, impacting early learning experiences (Ramirez et al., 2018; Schaeffer et al., 2020; Artemenko et al., 2020; Daker, et al., 202). Understanding the mechanisms by which teacher anxiety impacts students' learning and development, as well as the complex interactions between teacher self-efficacy and teaching effectiveness, is crucial for preventive interventions. Therefore, it was undertaken with the aim of exploring how undergraduates' math anxiety and self-efficacy beliefs may be related to their actual numeracy abilities.

2. RESEARCH METHOD

Quantitative research methods were used in the study. Participants were prospective teachers from State University of Malang. This research was conducted in the odd semester of the 2024/2025 academic year, specifically from April to September 2024. The population of this study is the 2022 class of prospective primary school teachers at State University of Malang. The sample was selected using the simple random sampling technique. Specifically, the population size in this study is 206 prospective primary school teachers. The sample size of this study is 130 respondents. Data collection in this study was conducted using questionnaires and tests.

There are three variables in this study. The independent variables include math anxiety (X1) and self-efficacy (X2). The next variable is the student's numeracy performance (Y). Based on the previously mentioned variables, the design of the study is as shown on **Figure 1**.

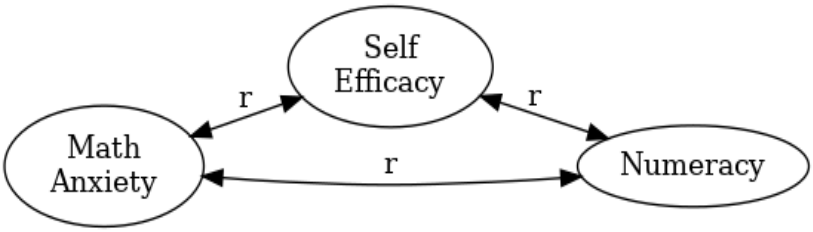

Figure 1. Design of the study

Details:
X1 : Math anxiety variable
X2 : Self-efficacy variable
Y : Numeracy performance variable
r1 : The partial effect of math anxiety on numeracy performance
r2 : The partial effect of self-efficacy on numeracy performance
r3 : The simultaneous influence of math anxiety and self-efficacy on numeracy performance

Questionnaires were used to obtain data on math anxiety and self-efficacy. Meanwhile, the test was used to obtain data on the numeracy skills possessed by prospective primary school teachers. Therefore, the research instruments used were numeracy tests, math anxiety questionnaires, and math self-efficacy questionnaires that were developed systematically, valid and reliable. The numeracy test, consisting of 10 items, is developed by researchers based on numeracy indicators. The mathematics anxiety questionnaire, developed from Cook & Mulyana's concepts, which was tested using logical validity and empirical validity before use. Pearson Product Moment Correlation analysis was used to examine the relationships between math anxiety, self-efficacy, and numeracy skills (Seng, 2015) (Ramirez et al., 2018) (Ongcoy et al., 2023).

This research uses descriptive analysis, correlation, and multiple regression to describe the research results, examine the relationship between numeracy scores and math anxiety and math self-efficacy, as well as to determine the influence of math anxiety and self-efficacy on numeracy scores among prospective primary school teachers. The analysis in this study uses the Jeffreys's Amazing Statistics Program (JASP) statistical analysis software. Multiple regression analysis is used in this study because the number of independent variables used is more than two. Before conducting hypothesis testing, the data must first undergo prerequisite testing. Prerequisite tests include normality test, linearity test, multicollinearity test, and heteroscedasticity test. In multiple regression analysis, there are math anxiety and self-efficacy as independent variables and numeracy ability as the dependent variable. Meanwhile, the hypothesis in this study is:

H_0 = *There is no significant effect of math anxiety and self-efficacy on students' numeracy skills.*
H_1 = *There is a significant effect of math anxiety and self-efficacy on students' numeracy skills.*

The decision on the hypothesis test is obtained through the comparison of the t-table and the t-calculated values. Where, the value of α = significance level = 5% = 0.05. If the calculated t-value is greater than the table t-value with a significance level < 0.05, then H_0 is rejected, H_1 is accepted, which means there is an influence between math anxiety and self-efficacy on students' numeracy skills. Conversely, if the calculated t-value is less than the table t-value with a significance level > 0.05, then H_0 is accepted, H_1 is rejected, which means there is no influence between math anxiety and self-efficacy on students' numeracy skills.

3. RESULTS AND DISCUSSION

This study aims to determine the levels of math anxiety, self-efficacy, and numeracy skills of prospective primary school teacher students, as well as the correlations between them. The descriptive statistics of the data were gathered and examined as shown on **Table 1**.

Table 1. Descriptive statistics

Statistics	Math Anxiety	Self-efficacy	Numeracy
Valid	130	130	130
Mean	68.662	72.492	69.538
Median	70.000	71.000	70.000
Mode	75.000	68.000	80.000
Std. Deviation	11.540	9.093	15.975
Variance	133.171	82.686	255.212
Range	64.000	55.000	80.000
Minimum	35.000	44.000	20.000
Maximum	99.000	99.000	100.000
Sum	8926.000	9424.000	9040.000

Prerequisite tests, such as the normality, linearity, multicollinearity, and heteroscedasticity tests, were then carried out. The results of the following prerequisite tests were derived from the analysis of the research data using JASP shown on **Table 2**.

Table 2. Results of the classical assumption

Classical assumption test	Criteria	Results		Conclusion
		X_1	X_2	
Normality Test	Sig. (2-tailed) > 0.05	0.288	0.288	The normality of the residuals is met.
Linearity Test	Sig. > 0.05	F=1.126 with sig.0.317		The linearity assumption is fulfilled.
Multicollinearity Test	VIF < 10.00	2.171	2.171	All data show no indications of
	Tolerance > 0.10	0.461	0.461	multicollinearity.
Heteroskedasticity Test	p-value > 0.05	0.66	0.66	The assumption of homoscedasticity is met (no heteroskedasticity problem)

According to **Table 2**, all research data have successfully met the required tests. The data is then used to test the hypothesis of the study. To determine the hypothesis test, the hypothesis used is:

H_0 = *There is no significant effect of math anxiety and self-efficacy on students' numeracy skills.*
H_1 = *There is a significant effect of math anxiety and self-efficacy on students' numeracy skills.*

The following **Table 3** until **Table 5** presents the outcomes of the multiple linear regression analyses that demonstrate the findings of the research hypothesis tests.

Table 3. t Test Results

Coefficients					
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**p**
	B	**Std.Error**			
Math Anxiety (X1)	-0.265	0.178	-0.192	-1.492	0.138
Self Efficacy (X2)	-0.008	0.226	-0.005	-0.037	0.971

Based on the coefficients shown on **Table 3** from the multiple regression analysis, both Math Anxiety (X1) and Self Efficacy (X2) show negative relationships with the dependent variable. Math anxiety has an unstandardized coefficient (B) of -0.265, this suggests that for every one-unit increase in math anxiety, there is a predicted decrease of 0.265 units in the dependent variable, holding self efficacy constant. However, this relationship is not statistically significant (t = -1.492, p = 0.138). Self Efficacy shows a very weak negative relationship with an unstandardized coefficient of -0.008 (standard error = 0.226), this indicates that for every one-unit increase in self efficacy, there is a minimal predicted decrease of 0.008 units in the dependent variable, holding math anxiety constant. This relationship is also not statistically significant (t = -0.037, p = 0.971). Overall, neither math anxiety nor self efficacy appear to be significant predictors of the dependent variable in this model.

Tabel 4. F test results

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
H^1	Regression	1166.191	2	583.096	2.332	0.101
	Residual	31756.117	127	250.048		
	Total	32922.308	129			

Based on **Table 4**, it can be seen that the p-value is 0.101. Meanwhile, to obtain a significant difference, the significant p value is <0.001. It can be concluded that the data do not show any significant differences in the results of the Numeracy Test with students' math anxiety and self-efficacy. Thus, it can be concluded that math anxiety (X1) and self-efficacy (X2) do not have a significant effect on students' numeracy skills. This is evidenced by the significance value p > 0.001, which means H_0 is accepted while H_1 is rejected. The coefficient of determination for the influence of math anxiety (X1) and self-efficacy (X2) on numeracy skills is presented in **Table 5**.

Tabel 5. Linear Regression Model Summary

Model	**R**	**R2**	**Adjusted R2**	**RMSE**
Ho	0.000	0.000	0.000	15.975
H1	0.188	0.035	0.020	15.813

Based on **Table 5**, it can be seen that the R^2value for H_0= 0.000, indicating that there is no prediction or variance explained. Meanwhile, the R^2 value for H_1= 0.035, which is the explanatory variance or the variance of the Numeracy Test that can be explained by Math Anxiety and Self Efficacy. Thus, math anxiety and self-efficacy can explain numeracy ability (Y) by 0.035 or 3.5%, while the remaining 96.5% of numeracy ability is influenced by other variables that were not studied.

Table 6. Pearson Correlation Results

Variable		**Math Anxiety**	**Self Efficacy**	**Numeracy Test**
Math Anxiety	Pearson's r	-		
	p-value	-		
Self Efficacy	Pearson's r	-0.734	-	
	p-value	< .001	-	
Numeracy Test	Pearson's r	-0.188	0.136	-
	p-value	0.032	0.123	-

Based on **Table 6**, the Pearson correlation analysis revealed several relationships between math anxiety, self efficacy, and numeracy test results. There is a strong negative correlation between math anxiety and self efficacy (r = -0.734, p < .001), indicating that as self-efficacy increases, math anxiety significantly decreases, or vice versa. However, in the relationship between math anxiety and numeracy test results, there is a weak negative correlation (r = -0.188, p = .032), suggesting that higher levels of math anxiety are slightly associated with lower numeracy test scores. Meanwhile, self efficacy and numeracy test showed a weak positive correlation (r = 0.136, p = .123), suggesting that higher self-efficacy is associated with slightly better numeracy test performance, however, this correlation is not statistically significant since the p-value > .05.

The multiple regression analysis revealed that the joint influence of arithmetic anxiety and self-efficacy on numeracy test performance was low. The model explained only 3.5% of the variance in test scores (R^2 = 0.035), and the overall model was not statistically significant (F (2.127) = 2.332, p = 0.101). Neither math anxiety (β = 0.265, p = 0.138) nor self-efficacy (β= -0.008, p = 0.971) were identified as significant predictors of numeracy performance. The result of the path analysis diagram shown in **Figure 2.**

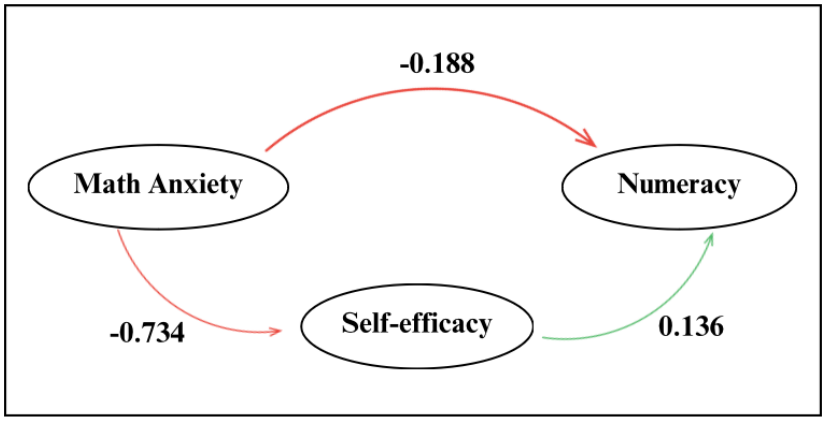

Figure 2. Results of Path Analysis Diagram

The results in **Figure 2,** revealed that there is a significant relationship between math anxiety, numeracy, and self-efficacy. The strong negative correlation (-0.734) indicates that math anxiety tends to decrease with an increase in self-efficacy. The relationship between math anxiety and numeracy skills is weakly negative (-0.188), suggesting that, although this correlation is not strong, higher math anxiety may be slightly related to lower numeracy skills. Meanwhile, there is a weak positive correlation (0.136) between self-efficacy and numeracy skills. Overall, these findings suggest that improving self-efficacy can help reduce math anxiety and possibly enhance numeracy skills. However, other factors may also play a significant role in numeracy skills.

The findings indicate that math anxiety and self-efficacy have a strong negative correlation, meaning that when self-efficacy increases, math anxiety tends to decrease, and vice versa. These findings are consistent with previous studies that also established a strong relationship between math anxiety and self-efficacy, suggesting that as self-efficacy increases, math anxiety tends to decrease (Burns et al., 2020). Siswanti and Djalal (2017) also found a significant impact of mathematical self-efficacy on the mathematics anxiety but on junior high school students. On the other hand, Lee (2009) found that math anxiety and math self-efficacy are empirically distinct concepts. This contrast seems to indicate that math anxiety and self-efficacy vary depending on the context and situation. Meanwhile, in the correlation analysis, we found that mathematical self-efficacy explains 73.4% of mathematical anxiety. Furthermore, Siswanti & Djalal (2017) found that mathematical self-efficacy contributes 46.3% to math anxiety. According to social learning theory, math anxiety can also be linked to a lack of self-efficacy. If a student feels anxious about math, they almost certainly believe that they are not capable of doing it well (Akin & Kurbanoglu, 2011). Similarly, the stronger a person's self-efficacy, the more actively they will strive and the longer they will persist in a particular task or behavior despite obstacles. Therefore, math anxiety can be used as an indicator of self-efficacy; higher math anxiety is associated with lower reported levels of self-efficacy. In terms of the impact of math anxiety, study participants who failed tests of numerical and/or numeracy skills were significantly more anxious about calculations than those who scored better. Additionally, it was found that there was a significant negative correlation between participants' level of anxiety in mathematics and their level of efficacy in numeracy tests (McMullan, et.al, 2012).

The relationship between math anxiety and numeracy skills is weakly negative. The weakness of that relationship may be partly due to the research sample consisting of university students. A meta-analytic investigation of 49 studies by Zhang et al. (2019) concluded that the negative relationship between math anxiety and math performance is strongest among high school students. Although this correlation is not strong, higher math anxiety may be slightly related to lower numeracy skills. The research by Mangkuwibawa et al. (2024) shows a significant negative influence of 21.71% by math anxiety on numeracy. Thus, the relationship between the two variables moves in opposite directions, which means that an increase in students' math anxiety will be followed by a decrease in their numeracy skills. In other words, the higher the students' math anxiety, the worse their numeracy skills.

Furthermore, the weak positive correlation between self-efficacy and numeracy skills indicated that higher self-efficacy was associated with slightly better numeracy test performance. This finding is consistent with the broader literature, which acknowledges self-efficacy as an important component impacting academic accomplishment in mathematics and numeracy (Yustitia et al., 2021; Yustitia, 2022; Indraswara et al., 2023). Yustitia et al. (2021) found a positive association between self-efficacy and numeracy skills among prospective primary school teachers, showing that self-efficacy explained a portion of the variance in numeracy skills.

Previous research has found that both math anxiety and self-efficacy have a moderate correlation with numeracy skills, indicating that these psychological factors may play an important role in individual math performance (Barroso et al., 2020). According to D'Agostino et al. (2021), these factors may be significant in shaping a person's math performance and

competence. However, Macmull and Ashkenazi (2019) discovered that while math anxiety correlates with mathematical performance, its predictive power diminishes when accounting for additional factors, such as early arithmetic skills and attitudes towards mathematics. This complexity is further supported by Jameson et al. (2022), who found that although mathematical self-efficacy is crucial in understanding math anxiety's influence on performance, it does not independently serve as a substantial predictor of numeracy results. Their research suggests that emotional self-efficacy, while relevant, does not significantly buffer the relationship between math anxiety and performance, indicating that other factors may be more influential in determining numeracy skills. This aligns with earlier findings by Meece et al. (1990), who observed that while efficacy-related assessments strongly predict math anxiety, they do not have a direct correlation with mathematical ability. Consequently, in this study, we found that neither math anxiety nor self-efficacy were identified as significant predictors of numeracy performance, suggesting that the relationship between these psychological factors and actual mathematical performance is more complex than previously thought.

4. CONCLUSION

This study examined the interrelationships between math anxiety, self-efficacy, and numeracy skills among university students. The findings revealed that while math anxiety and self-efficacy are strongly interconnected, their impact on numeracy performance is less pronounced than anticipated. The weak correlations found between math anxiety and numeracy and between self-efficacy and numeracy, is only 3.5%. This suggests that there are still 96.5% of other potential predictors that have not been identified in this study. Implying that the relationship between psychological factors and mathematical performance is more complex than previously theorized. These results challenge traditional assumptions about the direct influence of psychological factors on numeracy skills and indicate the need for a more comprehensive approach in understanding and improving students' mathematical performance. Future research should explore additional factors that might play more significant roles in determining numeracy competence among university students or conducting studies on a broader subject for wider generalization.

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