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# The relationship between self-efficacy and students' mathematical literacy

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© 2023 The Authors. This open access article is distributed under a (CC-BY License) **Abstract:** This research aims to determine the relationship between the dimensions of self-efficacy and students' mathematical literacy. The participants in this research were 103 grade 11 students at SMA N 1 Gandapura Bireuen. This research is in the form of an expository with a quantitative approach. Data was collected through self-efficacy questionnaires and mathematical literacy questions. Analysis of this research data used SEM PLS assisted by the Smart-PLS. The research results show that the dimensions of generality and strength significantly correlate with athematic literacy and are in a strong category. The magnitude dimension is significantly related to mathematic literacy but is in the medium category. Such conditions indicate the need to increase attention to the magnitude dimension by aspiring to authentic learning.

Keywords: Mathematical literacy, self-efficacy, math problems.

## Introduction

The progress of a country can be seen from the quality of education it has. As science develops, of course, the quality of education increases (Hirsh-Pasek et al., 2015). The ability to solve various problems faced in life through mathematics is a benchmark for students' success in studying mathematics (Boyd & Ash, 2018; Hasibuan et al., 2019). Learning mathematics is not just about mastering concepts, but, more than that, applying concepts that have been understood to solve various real problems (Laurens et al., 2017; Margot & Kettler, 2019). To achieve this goal, students must be prepared from an early age to master solving mathematical problems related to real problems.

Mathematics, which is packaged in the form of real problems, must be mastered by students to make it easier for them to solve every obstacle they face in everyday life (Martin, 2018; Sumirattana et al., 2017). However, in reality, students often have difficulty solving mathematics problems related to everyday problems. This is in line with what was stated by Rizki and Priatna (2019), that students still experience problems every time they work on mathematics problems presented in story form or related to everyday problems. The obstacles experienced are caused by students rarely being trained to solve reallife problems (Collins et al., 2018). So, special attention is needed so students can more easily understand the questions presented in story form. Students' ability to solve mathematical problems related to everyday problems can be improved by mastering mathematical literacy (Börner et al., 2019; Kastberg et al., 2016).

Mathematical literacy describes mastery of reasoning, concepts, facts, and mathematical tools to solve real-life problems (Fitzallen, 2015; Gravemeijer et al., 2017; Stacey & Turner, 2014). Mastering literacy will enable students to keep up with the demands of the times because mathematical literacy is one of the high-level abilities needed today (Genc & Erbas, 2019). Mathematical literacy will make students able to reason mathematically and thus be able to solve problems using a more structured method (Hermawan et al., 2019; Marsitin & Sesanti, 2023) so that the goals that have been set can be achieved more easily.

The mathematical literacy that students have when solving mathematical problems can also be seen in the PISA assessment results. PISA is implemented to assess student literacy at the age of 5 years, focusing on mathematics, science, and reading (Gurria, 2016). Literacy assessed in PISA emphasises the abilities and skills students acquire from school and how much they can use them to solve everyday problems (OECD, 2015). PISA 2018 shows that in mathematics, Indonesia is ranked 73rd out of 79 countries (OECD, 2018). This represents the condition of mathematical literacy possessed by Indonesian students. This lift shows conditions that are far from expectations. So, it requires a special study of mathematical literacy to find specific obstacles experienced by students and then create solutions to get better results.

Mathematical literacy is closely related to skills in solving various mathematical problems in real contexts (Börner et al., 2019; Rosa & Orey, 2015). The large impact that mastery of mathematical literacy can have makes mathematical literacy very important and must be mastered by students to be able to answer various problems faced outside of school (Gravemeijer et al., 2017; Kastberg et al., 2016; Stacey, 2015). Students must be prepared to face various possible challenges in the future. The government has attempted to increase student literacy in Indonesia through school literacy by inviting all educational practitioners to play an active role in contributing ideas through curriculum preparation and management of school facilities so that students' mathematical literacy skills can increase rapidly (Firdaus & Herman, 2017). Teachers are one of the educational practitioners as the main support in increasing students' mathematical literacy (Geiger et al., 2015; Speer et al., 2015). Teachers must understand their students' needs and know their abilities' development.

Apart from cognitive abilities, teachers must also pay attention to the affective abilities of students. One of the affective abilities students must have is selfefficacy (Bozdağ & Kaya, 2016; Cleary et al., 2017). Many students have low self-efficacy (Masitoh & Fitrivani, 2018; Nurlu, 2015), so they easily give up when facing obstacles in learning and solving mathematics problems (Ozkal, 2019; Samuel & Warner, 2021). Insufficient self-efficacy will make things difficult for students and reduce students' enthusiasm for mastering mathematics (Roick & Ringeisen, 2018; Simamora & Saragih, 2019). Confidence in their abilities greatly influences students' success in learning (Bradley et al., 2017; Sha et al., 2016). Therefore, every student must have a good level of self-efficacy to feel comfortable facing difficult things and go through them well.

According to Bandura, self-efficacy is divided into three dimensions (Bandura, 1999) first, The level/magnitude dimension relates to the level of difficulty of the work completed by students (Badrun et al., 2022; Maksum et al., 2019). Students' level of selfefficacy determines their confidence level in solving simple to complex problems that require high competence (Street et al., 2017; Waluya & Asikin, 2021). High self-efficacy brings students into the habit of solving challenges so that difficulties at various levels can be overcome well.

Second, The general dimension concerns the breadth of knowledge mastered by students regarding the problems they face (Dixon et al., 2020; Siboro et

al., 2022). The self-efficacy possessed by students is very diverse. Some are in certain fields, and others are in several at once, even in opposing fields (Liu et al., 2020; Schunk & DiBenedetto, 2016). Usually, students with high self-efficacy will master many fields (Filippou, 2019) and are willing to learn all of them because they realize the interrelationship of each field they study (Charleston & Leon, 2016).

Third, The strength dimension includes how strong the confidence a student has to solve a problem (Perera & Priyanath, 2022; Putri & Prabawanto, 2019). The results achieved by students in solving various problems according to expectations show how strong their beliefs are in that field (Ahn et al., 2016). Strong belief in their abilities is the basic foundation for students to be able to solve various problems even though they often experience obstacles (Faradilla et al., 2022; Mukhibin & Himmah, 2020). Each obstacle is a challenge that must be resolved to achieve the expected goal.

Students' mathematical literacy can be seen from their self-efficacy level. This is in line with what was expressed by Gabriel et al. (2018), who stated that the level of self-efficacy greatly influences students' mathematical literacy. So, these two abilities require special attention to succeed in mathematics. This research was written to review the influence of selfefficacy on mathematical literacy based on the dimensions of self-efficacy itself. A more detailed review will help the teacher know the parts that still need attention so they can choose the right strategy.

Previous research analyzed mathematical literacy directly with students' self-efficacy (Aksu & Güzeller, 2016; Busnawir et al., 2021; Gabriel et al., 2018; Gerde et al., 2018; Hiller et al., 2022). However, this research will be analyzed in more detail by reviewing the dimensions of self-efficacy itself. This research aims to provide an overview of the relationship between the influence that self-efficacy has on its dimensions of mathematical literacy abilities. The formulation of the problem in this research is whether each dimension of self-efficacy has a relationship with mathematical literacy.

## Method

This research uses a quantitative expository approach where when the research takes place, the selected sample already has the variables to be studied and without any treatment. Samples were selected using random sampling techniques with the Slovin method to determine their size. The random sampling technique will give the population an equal chance of being selected. Through the Slovin method, the selected sample is representative of the population. Through this method, the selected sample was 103 grade 11 high school student. This research uses a comparative causal method to determine the relationship between self-efficacy and mathematical literacy. One analysis that explains the results in the form of cause-and-effect relationships between variables is SEM-PLS covariance analysis. This analysis uses non-parametric calculation results, so it does not have a prerequisite test in data normality. This research data was collected using a self-efficacy questionnaire and mathematical literacy test questions.

## Result

## Outer Model

The outer model is analyzed to see the validity and reliability of the data used. Data that does not meet validity can be eliminated through the outer model. This is an advantage of SmartPLS analysis, which does not require normally distributed data.

Table 1	. Indikator	yang	dianalisis	dari	variabel	self	efficacy
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Self Efficacy (SE) indicator	Magnitude (M)	Generality (G)	Strength (S)
1	MSE1	GSE1	SSE1
2	MSE2	GSE2	SSE2
3	MSE3	GSE3	SSE3
4	MSE4	GSE4	SSE4

Note:

MSE : Magnitude Self Effica	acy
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GSE : Generality Self Efficacy

	SSE	: Strength Self Efficacy
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- a. Self-efficacy dimension of magnitude with an indicator of confidence in understanding all the material studied (MSE1)
- b. Self-efficacy dimensions of magnitude with indicators of confidence in choosing the right strategy (MSE2)
- c. Self-efficacy dimension of magnitude with indicators of confidence in solving questions of various levels of difficulty (MSE3)
- d. Self-efficacy dimensions of magnitude with indicators of confidence in getting satisfactory results (MSE4)
- e. Generality dimension of self-efficacy with an indicator of confidence in understanding all the material studied (GSE1)
- f. Self-efficacy generality dimension with indicators of confidence in choosing the right strategy (GSE2)
- g. Generality dimension of self-efficacy with indicators of confidence in solving questions of various levels of difficulty (GSE3)
- h. Generality dimension of self-efficacy with indicators of confidence in getting satisfactory results (GSE4)
- i. Self-efficacy, strength dimension with indicators of confidence in understanding all the material studied (SSE1)
- j. Self-efficacy dimension of strength with indicators of confidence in choosing the right strategy (SSE2)
- k. Self-efficacy, strength dimension with indicators of confidence in solving questions of various levels of difficulty (SSE3)
- l. Self-efficacy dimension of strength with indicators of confidence in getting satisfactory results (SSE4)

The collected data is then analyzed with a score of 0, 1, 2, 3, or 4. The statements prepared consist of positive statements and negative statements. Positive statements with the condition never are given a score of 0, a score of 1 if rarely, a score of 2 for the sometimes category, a score of 3 if often, and a score of 4 for the always done category. Meanwhile, the score calculation for negative statements is reversed based on the positive statement category. The mathematical literacy variable was analyzed through 4 questions, each having four indicators of mathematical literacy.

- a. Able to model or formulate mathematical problems
- b. Able to choose strategies and use formulas
- c. Able to analyze information using the concept of mathematical operations
- d. Able to analyze conclusions and evaluate conclusions

Figure 1 displays several outer loading values that are less than 0.7. Outer loading values below 0.7 must be eliminated because they indicate invalid indicators. Indicators that must be removed include the MSE1 selfefficacy variable. Meanwhile, the mathematical literacy indicators are LMKK1 and LMKN4. After elimination, the remaining data will be analyzed until all valid and usable data is obtained.

This stage 2 analysis shows that all data already has an outer loading value above 7.0, so it can be considered valid. Next, the validity and reliability of the data will be reviewed.

## Validity test

The first validity test in this analysis is convergent validity. Convergent validity is analyzed to determine the validity of the relationship between each indicator and its latent variable. Convergent validity can be reviewed based on the outer loading value. If the outer loading value is > 0.7, then it can be said that the data is valid. Figure 2 shows that all outer loading values are > 0.7, so it can be said that each indicator has a valid relationship with the latent variable. Convergent validity can also be seen in the AVE value obtained. The expected AVE value is > 0.5, so it is valid.

Table 3 shows that the AVE value for each variable exceeds 0.5, so it can be said that the data has convergent validity. Next, discriminant validity is analyzed to ensure that the relationship between the observer variable and the construct is higher than the relationship between the observer variable and the relationship between the observer variable and the construct is expected to be higher, it should not exceed 0.9. Discriminant validity can be seen through the cross-loading table.

These indicators are categorized into three dimensions of mathematical literacy, which can be seen as follows:

## Table 2. Indicators of mathematical literacy

Question No	Indicator	Indicator No	Manifest Variables
	Able to model or formulate mathematical problems	1	LMKK1
	Able to choose strategies and use formulas	2	LMPR1
	Able to analyze conclusions and evaluate conclusions	4	LMKN1
	Able to model or formulate mathematical problems	1	LMKK2
2	Able to analyze information using the concept of mathematical operations	3	LMPO2
	Able to analyze conclusions and evaluate conclusions	4	LMKN2
	Able to model or formulate mathematical problems	1	LMKK3
3	Able to choose strategies and use formulas	2	LMPR3
	Able to analyze conclusions and evaluate conclusions	4	LMKK4
	•		LMKK4
	Able to model or formulate mathematical problems	1	
4	Able to analyze information using the concept of mathematical operations	3	LMPO4
	Able to analyze conclusions and evaluate conclusions	4	LMKN4





Table 3. AVE Value

	Average Variance Extracted (AVE)
Generality	0,745
Literasi Matematis	0,697
Magnitude_	0,783
Self Efficacy	0,691
Strength	0,749

Table 4 shows that the relationship between observer variables and the construct is higher than the relationship between observer variables and other constructs and does not exceed 0.9. Thus, the data is categorized as having discriminant validity.

## **Reliability Test**

Reliability testing is used to analyze the accuracy of the data obtained. Data is said to be reliable if the composite reliability value is > 0.5 and Cronbach's alpha is> 0.6.

The table above shows that the composite reliability value is > 0.5 and Cronbach's alpha > 0.6, so the constructs are reliable and can be used to test the samples that have been determined. After evaluating the model, all valid and reliable data is obtained to be further evaluated through the inner model.



Figure 2. Evaluation of Outer Model Stage 2

#### Table 4. Values cross loading

	Generality	Literasi Matematis	Magnitude_	Self Efficacy	Strength
Generality	0,863				
Literasi Matematis	0,777	0,835			
Magnitude_	0,827	0,733	0,885		
Self Efficacy	0,957	0,776	0,934	0,831	
Strength	0,896	0,711	0,878	0,971	0,865

Table 4 shows that the relationship between observer variables and the construct is higher than the relationship between observer variables and other constructs and does not exceed 0.9. Thus, the data is categorized as having discriminant validity.

#### Table 5. Reliability Test

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Generality	0,886	0,888	0,921	0,745
Literasi Matematis	0,951	0,953	0,958	0,697
Magnitude_	0,861	0,865	0,915	0,783
Self Efficacy	0,955	0,956	0,961	0,691
Strength	0,888	0,890	0,923	0,749

The table above shows that the composite reliability value is > 0.5 and Cronbach's alpha > 0.6, so the constructs are reliable and can be used to test the samples that have been determined. After evaluating the model, all valid and reliable data is obtained to be further evaluated through the inner model.

## Inner Model

The inner model or structural analysis is tested to see the direct and indirect influence between variables. This analysis displays R-Square as a proportion value until a final decision is obtained from the hypothesis that has been designed. Following are the measurement results using SmartPLS via bootstrap resampling.

#### Path Coefficient

The path coefficient value determines the percentage of influence the self-efficacy variable has on mathematical literacy. Through the path coefficient, you can also determine the structural equation built by this research's objectives. The categories of influence between variables are determined as follows:

 $0.00 \le x < 0.05$  (very weak)

 $0.05 \le x < 0.10$  (weak)  $0.10 \le x < 0.29$  (medium)  $x \ge 0.30$  (strong)

#### Table 6. Path Coefficient Values

	Original Sample (O)	Influence
Generality -> Self Efficacy	0.383	Strong
Magnitude> Self Efficacy	0.290	Currently
Self-Efficacy -> Mathematical Literacy	0.776	Strong
Strength -> Self Efficacy	0.373	Strong

Table 6 above shows that only the magnitude dimension influences the medium category. Meanwhile, other variables are in the strong category. This shows that the self-efficacy dimension has a strong influence on mathematical literacy. Self-efficacy

#### R-Value 2 (R Square)

R square shows how many factors influence the mathematical literacy variable. R square measures the quality of the model, and the determinant coefficient shows how much influence the self-efficacy variable has on the mathematical variables.

#### Table7. R-value<sup>2</sup>

	R Square	R Square Adjusted
Mathematical Literacy	0,602	0,598
Self Efficacy	1,000	1,000

R square measurement for the mathematical literacy variable:

Determinant coefficient =  $0.598 \times 100\% = 59.8\%$ based on the calculation of the determinant coefficient, it is obtained that it is 59.8%, meaning that the mathematical literacy variable is influenced by the self-efficacy variable by 59.8%. Meanwhile, the remaining 40.2% is influenced by other variables outside this research. This shows that self-efficacy influences students' mathematical literacy by more than 50%.

## Predictive relevance (Q2)

 $Q^2$  is used to measure the suitability of the model's relevance between the self-efficacy variable and mathematical literacy based on the built structure. The value  $Q^2 > 0$  means that the structural model built has good Predictive relevance, whereas the value  $Q^2 < 0$ 

means that the structural model built has Predictive relevance in the poor category.

Table 8.	Stone Glesser Value (Q <sup>2</sup> )	

	SSO	SSE	Q <sup>2</sup> (=1- SSE/SSO)
Generality	412,000	412,000	
Literasi Matematis	1030,000	602,814	0,415
Magnitude_	309,000	309,000	
Self Efficacy	1133,000	357,941	0,684
Strength	412,000	412,000	

Stone Glesser Value table shows that the  $Q^2_{value}$  for the self-efficacy and mathematical literacy variables is > 0, so it can be said that the exogenous variable has good predictive relevance to the endogenous variable.

#### Partial Effect Measures

The partial effect size is used to determine the category of influence that the self-efficacy variable has on mathematical literacy. These categories can be classified as follows

 $0.00 \le x < 0.2$  influence in the weak category  $0.02 \le x < 0.15$  influence in the medium category  $0.15 \le x < 0.35$  influence in the strong category  $x \ge 0.35$  influence in the very strong category

## Table9. Partial Effect Size (f<sup>2</sup>)

	Literacy Matematis		
Self Efficacy	1,514		

Table 9 shows that self-efficacy partially influences mathematical literacy by 1.514. This shows that self-efficacy and mathematical literacy have a very strong relationship.

statistical hypothesis test will be carried out to answer the research formulation by reviewing the pvalue. The p-value is > 0.05, so H0 is rejected, and H1 is accepted. Test the statistical hypothesis in this research as follows:

- 1. The relationship between magnitude dimensions and mathematical literacy
- $H_0$ : There is no significant relationship between the magnitude dimension and mathematical literacy
- H<sub>1</sub>: There is a significant relationship between the magnitude dimension and mathematical literacy p-value = 0.00

 $\alpha$ = 0.05 > 0.00 then H<sub>0</sub> is rejected, and H<sub>1</sub> is accepted

#### Table 10. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	P Values
Generality -> Self Efficacy	0,383	0,382	0,011	34,432	0,000
Magnitude -> Self Efficacy	0,290	0,291	0,010	28,458	0,000
Self-Efficacy -> Mathematical Literacy	0,776	0,777	0,049	15,721	0,000
Strength -> Self Efficacy	0,373	0,373	0,011	32,674	0,000

This means that there is a significant relationship between the magnitude dimension and mathematical literacy

- 2. The relationship between generality dimensions and mathematical literacy
- H<sub>0</sub>: There is no significant relationship between the generality dimension and mathematical literacy
- H<sub>1</sub>: There is a significant relationship between the generality dimension and mathematical literacy p-value = 0.00
- $\alpha$  = 0.05 > 0.00 then H<sub>0</sub> is rejected, and H<sub>1</sub> is accepted.

This means that there is a significant relationship between the generality dimension and mathematical literacy.

- 3. The relationship between the dimensions of strength and mathematical literacy.
- H<sub>0</sub>: There is no significant relationship between the strength dimension and mathematical literacy
- H<sub>1</sub>: There is a significant relationship between the strength dimension and mathematical literacy p-value = 0.00
- $\alpha$  = 0.05 > 0.00 then H<sub>0</sub> is rejected, and H<sub>1</sub> is accepted

This means that there is a significant relationship between the strength dimension and mathematical literacy

## Discussion

Testing the hypothesis obtained from the results of calculating the research data, it was found that selfsignificant relationship efficacv has а with mathematical literacy. The data collected used instruments regarding mathematical literacy and selfefficacy, which were grouped into three dimensions. This grouping aims to see the influence of each dimension of self-efficacy on students' mathematical literacy. The influence of each self-efficacy dimension mathematical literacy shows a significant on relationship between these two abilities. Based on the original sample values, it shows a positive influence between mathematical literacy and self-efficacy for each dimension, so it can be interpreted that the higher the self-efficacy, the higher the students' mathematical literacy. This was also expressed by Letwinsky (2017) that students' self-efficacy can describe the condition of their mathematical literacy.

Self-efficacy is closely related to mathematical literacy (Kurniawati & Mahmudi, 2019). The feeling of confidence in students' abilities must be given special attention so that they do not experience difficulties when facing problems. Self-confidence in one's abilities can be reinforced through teacher reinforcement (Miller et al., 2017; Simamora & Saragih, 2019). Understanding and describing the failures that students may experience when solving problems can help them be more prepared and careful when solving problems such as mathematical problems. When students do not get the expected results, the teacher can provide understanding and encourage them to study again to consolidate their knowledge of the material. Good selfefficacy will make students' enthusiasm not easily weak even though they have not achieved what has been targeted.

The target size is usually determined by the student's curiosity about the problem being solved. High self-efficacy can also foster students' curiosity about the problems to be solved (Daher et al., 2021; Kim & Choi, 2019). Digging up information from various media so that you can answer problems can even make it possible to find things that were initially unrelated and become connected. So, they will dig further to answer their curiosity about what they have learned. To prevent students from obtaining invalid information, they need teacher guidance as a guide and director so that they can help them solve these problems. According to Schunk & DiBenedetto (2016), students with high self-efficacy can develop various abilities with continuous efforts. Currently, students at school must be prepared scientifically and mentally to balance the two to obtain maximum results when doing a job.

The original sample value shows how much the self-efficacv dimension variable influences mathematical literacy. The original sample table shows that the generality and strength dimensions are in the strong category, while the magnitude dimension is still in the medium category. The magnitude dimension refers to students' confidence in solving mathematical problems at various difficulty levels (Zay & Kurniasih, 2023; Zhou, 2016). In this case, it shows that students have not been optimal in solving questions in parts that are considered difficult. The magnitude dimension can be increased through ongoing authentic learning so that students know how big the problem they are facing (Dixon et al., 2020). Authentic learning can be obtained through discussion and building concepts that are interconnected meaningfully and involve real problems. Students master the entire scope of information regarding the problem being faced. Good self-efficacy can also help students deal with mathematics anxiety (Akkaya & Polat, 2022)

Students who have high self-efficacy are better able to master various mathematical subjects and are more enthusiastic about solving various mathematical problems, even though they are difficult, than students who have low self-efficacy (Öztürk et al., 2020; Psycharis & Kallia, 2017). Students' self-efficacy assessment of mathematics subjects can contribute to mathematics learning achievement when linked to mathematics learning achievement. High self-efficacy in mathematics lessons encourages students to be diligent, make serious efforts to pay attention and look for learning strategies to study and do mathematics tasks. The difficulties he faced in learning mathematics did not make him despair. It is this perseverance and effort that can make a positive contribution to students' mathematics learning achievements at school.

## Conclusion

The results of the data analysis show that there is a significant relationship between each dimension of self-efficacy and mathematical literacy. The relationship given by self-efficacy to mathematical literacy suggests that every student who studies mathematics must possess these two things. Therefore, encouragement is needed from every teacher who teaches mathematics classes to help their students increase their self-efficacy so that mathematical literacy can grow along with it. Good mathematical literacy can help students solve various mathematical problems at school and in everyday life.

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