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Attitude and Tenacity: Which One Mostly Affects Students' Mathematics Achievement?

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Abstract: This survey study aims to describe the simultaneous impact of students' attitudes toward mathematics and tenacity toward learning achievement and the partial effect of students' attitudes towards mathematics and tenacity on learning achievement in mathematics. The population of this research was 11th-grade students of a public school in Ngaglik, Yogyakarta, Indonesia, with 122 students as a sample selected by a simple random sampling technique. The data collection on students' attitudes toward mathematics and tenacity were obtained using a Likert-scale questionnaire. The questionnaires used in this study are valid and reliable. The data was analyzed using parametric statistics, which was multiple regression. The research results show that: 1) there was significant simultaneous impact on students' attitude towards mathematics and tenacity towards mathematics learning achievement; 2) there was no significant impact given by students' attitude towards mathematics learning achievement; 3) there was significant impact given by tenacity towards mathematics learning achievement. Implications and suggestions will be discussed in the discussion part.

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INTRODUCTION

Mathematics achievement is very important for students as it has a huge impact on many aspects of life, especially in STEM (science, technology, engineering, and math) fields. Math is also widely used in problem-solving, critical thinking, and analytical skills, which are useful in many ways, such as in personal and professional life. In addition, math achievement is closely linked to overall academic performance and significantly influences students' future career prospects (Abin et al., 2020; Jordan et al., 2010). In addition, math plays an important role in many fields, such as science and engineering, which are essential for technological advancement and progress. Students' proficiency in math enhances problem-solving, logical thinking, and analytical skills, which are useful in many aspects of life, such as making decisions, managing, and communicating (Cabuquin & Abocejo, 2023; Sreylak et al., 2022). However, many studies show that mathematics achievement is still relatively low (Forsblom et al, 2022; Barroso et al, 2021; Sampouw & Retnawati, 2020).

Factors influencing students' learning have recently been widely discussed in much research. Researchers believe that students' success in learning is not only influenced by students' cognitive factors but also non-cognitive factors. In recent years, mathematics educators and researchers have increasingly shown interest in the relationship between non-cognitive and cognitive domains.

Non-cognitive factors are frequently mentioned as motivational or psychological factors, which can be more important than cognitive factors (Dweck, Walton, & Cohen, 2014; Tough, 2012). It was proved by Duckworth & Seligman (2005), who found that non-cognitive factors, such as discipline, had an impact on

student's academic performance compared to student's intelligence level. Specifically in mathematics learning, recent research showed meaningful and inseparable relations between cognitive and non-cognitive or affective domains (Larkin & Jorgensen, 2015). It is in line with Ma & Kishor (1997), stating that there is a cognitive domain impact on each affective domain and the affective component on each cognitive domain.

The non-cognitive domain has broad characteristics, including motivation, tenacity, self-confidence, persistence, social skills, and communication (Gutman & Schoon, 2013). The content of this non-cognitive content refers to the affective factor. Factors such as learning tenacity, students' attitude towards mathematics, belief in learning mathematics, anxiety, motivation, and belief in the use of mathematics seem to greatly influence students' performance in learning mathematics (Nurrahmah, 2015). These factors are seen as students' internal factors, which encourage students to achieve good results in learning.

Students' attitude towards mathematics is an important factor in learning mathematics. Compared to the other factors which influence students' performance in learning, students' attitude toward mathematics becomes a consistent factor studied by researchers (Prendergast & Hongning, 2016). Students' attitude refers to the tendency of students to respond positively or negatively to an object, situation, concept, or other people (Aiken, 1970). More specifically, students' attitude toward mathematics is defined as positive or negative responses in terms of the importance, difficulty, and pleasure when studying mathematical materials, such as algebra, geometry, and trigonometry (Ma, 1997). Furthermore, students' attitudes towards mathematics can also be defined as student's pleasant or unpleasant feelings towards mathematics, the tendency to engage or avoid activities related to mathematics, the belief that mathematics is useful or not, the ease or difficulty of mathematics, and the importance or unimportance of mathematics (Ma & Kishor, 1997). From this explanation, it can be understood that students' attitude towards mathematics refers to student's feeling, which generates positive or negative responses related to the feeling that learning mathematics is important, difficult, or fun.

Much research shows that students' attitude toward mathematics is very important. In their research, Veresova & Mala (2016) discuss the importance of students' attitude towards learning as a significant thing in attaining learning achievement. Previous research mentions that there is a correlation between students' attitudes toward mathematics and mathematics learning outcomes (Atiaturrahmaniah & Rahayu, 2018; Haladyna & Thomas, 1979; Ma & Kishor, 1997; Ma, 1997; Papanastasiou, 2000; Roshal, Frieze, & Wood, 1971). Not only has correlation, but students' attitude is also seen as a significant factor in influencing student's learning achievement in mathematics (Farooq & Shah, 2008: 75; Purnomo, 2016: 102).

Besides students' attitudes towards mathematics, learning achievement is also influenced by students' tenacity. In fact, to accomplish learning achievement, students will encounter challenges that can be overcome using tenacity and optimism; thus, learning achievement should be accompanied by tenacity in learning (Nurrahmah, 2015). Tenacity is a broad concept that includes a set of dispositions that support learning and achievement inside and outside the school. Specifically, Tenacity includes resilience, persistence, fortitude, and self-regulation (Lucas & Spencer, 2018). In addition, Tenacity is about mindset and skill, which allow students to see something not in the short term but focus on the long term to achieve the highest goals and persist with challenges to achieve the goals (Gunawan, Endriani, & Malina, 2019). Furthermore, Dweck et al. (2014) state that tenacity in learning is about hard work and intelligent work for the long term. More specifically, tenacity is about mindset and skill that enable students to (a) look beyond short-term goals to long-term goals or the higher levels and (b) survive the challenges to achieve the goals set. From the explanation above, we can understand that tenacity is students' behaviors that show long-term tenacity, persistence, diligence, high willingness, hard work, and self-control. Hence, they do not give up when they encounter obstacles in an attempt to achieve the goals set.

The question that needs to be answered is: what does students' tenacity look like? Dweck et al. (2014) provide several characteristics and behaviors shown by students with academic tenacity: (a) they believe that they depend on school academically and socially. School is a part of their life and is seen as the right path to the future, such as benefiting their family, or contributing to their community or society;

(b) they engage in learning, view effort positively, and can leave momentary pleasure for schoolwork. For example, they are more likely to look for challenging assignments which will help them to learn new things, rather than assignments inside their comfort zone, which not only require less effort but also provide little opportunity to learn a lot; (c) they are not derailed by adversity, either intellectually or socially. They see regression as an opportunity to learn or a problem to be solved rather than as an insult, a curse on their ability or score, a symbol of future failure, or confirmation that they are not worthy; (d) they know how to survive in the long term and how to implement new strategies to move forward effectively.

Lucas & Spencer (2018) propose a framework that can be used in various subjects related to tenacity. The framework consists of 4 components: Confident, Controlled, Committed, and Connected. Confident refers to someone who is persistently aware of his/her self-efficacy. It means that they are oriented toward learning rather than performance. The sub-components of this habit are learning from mistakes, self-evaluation, and seeking challenges. Controlled relates to the ability to self-regulate. Someone with tenacity can control himself/ herself if needed to resist distraction. The sub-components of this habit are controlling impulses, resisting satisfaction, and sticking to the routine. Committed relates to a long view. They are able to survive adversity because they can see the value of the problem, which leads them to success. The sub-components of this habit are looking far ahead, keeping things in context, and staying optimistic. Connected relates to the understanding that there needs to be involvement with other people. They realize that their actions and thoughts can develop if they are willing to interact with other people. The sub-components of this habit are appreciating contributions, searching for feedback, and engaging with related groups.

Research discussing tenacity explicitly is still rarely found. However, as in the previous explanation, tenacity is related to self-efficacy in which students' self-efficacy becomes a mighty positive predictor in predicting students' learning outcome scores (Al-Harthy, Was, & Isaacson, 2010). Self-efficacy is also able to improve students' performance in solving mathematical problems (Hoffman & Spatariu, 2008). Furthermore, self-efficacy is closely related to someone's hard work (Lopez, Brown, Lent, & Gore, 1997) and persistence (Pajares & Kranzler, 1995). Students' hard work and persistence lead them to a successful learning achievement. These results indirectly prove that students' tenacity in learning mathematics highly influences students' learning achievement. Previous research has attempted to examine the influence of non-cognitive factors (attitude and tenacity) on student achievement and performance. However, there is still a lack of research that examines the simultaneous and partial influence of these factors. Partial influence will show the existence of non-cognitive factors that are dominant in influencing student achievement.

The theoretical explanation above shows that both students' attitudes toward mathematics and students' tenacity in learning influence students' learning achievement. In this research, the researchers conducted a survey to discover whether there was a simultaneous impact between students' attitudes toward mathematics and students' tenacity toward learning achievement. In addition, this research also looked at these two factors, which factor was more significant in influencing students' learning achievement. The results of this study will provide an overview for mathematics teachers to organize their learning to promote the improvement of non-cognitive factors as a support in improving mathematics achievement. Thus, the research questions in this study are: 1) is there a simultaneous effect of student attitudes towards mathematics and tenacity on student learning achievement? 2) does student attitude towards mathematics affect student learning achievement partially? 3) Does tenacity partially affect student learning achievement?

METHOD

This research is a survey that aims to examine the impact of students' attitudes towards mathematics and students' tenacity towards learning achievement in mathematics, as well as the partial impact between students' attitudes towards mathematics and students' tenacity towards learning achievement in mathematics. The population in this study were all 11th-grade students of public school in Ngaglik, Yogyakarta, Indonesia, with a research sample of as many as 122, which were selected using a simple random sampling technique.

The data on students' attitudes towards mathematics and students' tenacity were obtained using a questionnaire instrument. The questionnaire instrument used was a 5-point Likert scale. There were 36 points in the questionnaire for students' attitude towards mathematics and 25 points in the questionnaire for students' tenacity. Both of these questionnaires had been through the process of content validation by 3 experts and were tested to see their reliability. The estimation of reliability used Cronbach Alpha. The reliability coefficient of the questionnaire on students' attitude towards mathematics is 0.827, while the reliability coefficient of the questionnaire on student perseverance is 0.864. Meanwhile, the data on learning achievement in mathematics was obtained through the document of basic competency test score list on geometry transformation material.

The research procedure was carried out in three stages: preparation, data collection, and data analysis. At the preparation the questionnaire instrument was prepared and tested. At the data collection stage, students filled out the questionnaires on attitude and tenacity, which had been distributed. Besides, the collection of achievement data was carried out by asking for the file of the score list from the teachers who taught mathematics in grade 11. During the data analysis, data tabulation, descriptive statistical calculation, and inferential analysis were done. Descriptive statistics was carried out by calculating the attitude data distribution in positive, neutral, and negative categories and the tenacity data in high, medium, and low categories.

Table 1. Descriptive Statistics Interpretation

		Attitude Toward Mathematics		Tenacity	
Ideal minimum score (S_{Min})		36		25	
Ideal maximum score (S_{Max})		180		125	
Categories	$S_{Min} + 2p < S \leq S_{Max}$	Positive	$132 < S \leq 180$	High	$92 < S \leq 125$
	$S_{Min} + p < S \leq S_{Min} + 2p$	Neutral	$84 < S \leq 132$	Medium	$58 < S \leq 92$
	$S_{Min} \leq S \leq S_{Min} + p$	Negative	$36 \leq S \leq 84$	Low	$25 \leq S \leq 58$

S: students' total score, p: range length ($p = S_{Max} - S_{Min}$)

After analyzing the data in descriptive statistics, inferential analysis was carried out. Inferential analysis using multiple regression analysis.

RESULT AND DISCUSSION

Result

The recapitulation of descriptive statistical calculation result is as follows.

Table 2. Data Description

Variable	Category	Data Number	Percentage	Achievement Average	Achievement Deviation Standard
Students' Attitude	Positive	35	28.69%	77.96	3.626
	Neutral	86	70.49%	77.59	3.156
	Negative	1	0.82%	74.00	0
Tenacity	High	18	14.75%	79.56	3.884
	Medium	102	83.61%	77.74	3.196
	Low	2	1.65%	75.00	0
Achievement		122		77.96	3.349

Table 2 shows that students who have a positive attitude towards mathematics are 35 with an average achievement of 77.96, students who have a neutral attitude towards mathematics are 86 with an average achievement of 77.59, and there is only 1 student who has a negative attitude towards mathematics with the achievement of 74.00. Besides, at the tenacity level, there are 18 students with an

average of 79.56; at the medium level of tenacity are 102 students with an average of 77.74, and at the low tenacity level, there are 2 students with an average of 75.00.

In order for the regression model to be statistically valid, it is necessary to test the assumption. The assumptions that must be fulfilled are residual normality, heteroscedasticity, free from multicollinearity, and linearity. The results of the assumption test are presented as follows. The Test Results of Residual Normality Assumption, Multicollinearity, and Linearity between Learning Achievement and Predictors.

Table 3. Summary of Assumption Test.

Assumption	Statistical Test	Students' Attitude towards Mathematics	Students' Tenacity
Residual Normality	Kolmogorov-Smirnov	0,041	
	Sig.	0,200	
Multicollinearity	Tolerance	0,786	0,786
	VIF	1,273	1,273
Linearity	F Linearity	11,406	16,431
	Sig.	0,001	0,000

Table 3 shows that the Sig. Value = 0.200 > α = 0.05, which means that the residuals of the regression model are normally distributed. In addition, the Tolerance and VIF values of the two predictor/dependent variables are greater than 0.1 and less than 10. This means that there is no multicollinearity problem in the formed regression model. Furthermore, the assumption of heteroscedasticity was carried out by interpreting the scatter plot between standardized predicted value (ZPRED) and studentized residual (SRESID), which is presented below.

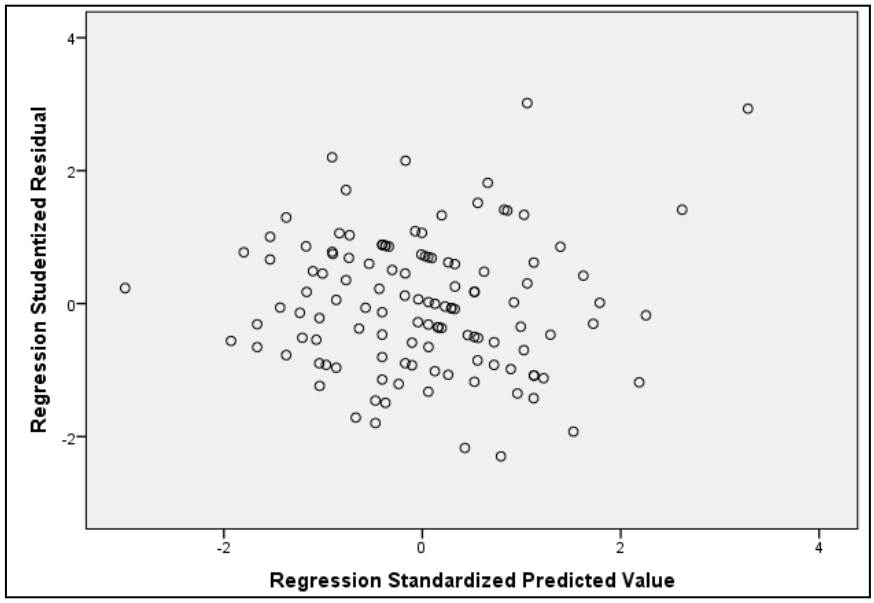

Figure 1. Scatter Plot of Heteroscedasticity

Figure 1 above shows that there is no particular pattern of the ZPRED and SRESID point mapping. The points are scattered above and below point 0 on the SRESID axis. This can be interpreted as the fact that there is no heteroscedasticity problem in the regression model that has been formed. Thus, the classical assumption in multiple regression was fulfilled, and the regression model was said to be statistically valid.

In analyzing the data using double regression, checking was first conducted to find out whether there were outliers data. Based on the checking result, one outlier was found, so it was not included in the data analysis. Further, a table of results for analysis and a summary of the double regression were made.

It is as follows.

Table 4. Summary of Anova for Regression

	Sum of Squares	*df*	Mean Square	*F*	*Sig.*
Regression	165.921	2	82.960	9.371	0.000
Residual	1044.691	118	8.853		
Total	1210.612	120			

Table 4 shows that the F value is 9,371 with a significance of 0,000. This indicates that there is a linear relationship between students' attitudes toward mathematics and tenacity with students' achievement. This has implications for the simultaneous impact of students' attitudes towards mathematics and students' tenacity on students' achievement. The magnitude of the simultaneous impact can be seen through the coefficient of determination (R Square). The calculation results of the coefficient of determination are presented as follows.

Table 5. Summary of Calculation of The Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.370	0.137	0.122	2.975

Table 5 shows the R Square coefficient of 0.137. This means that students' attitude towards mathematics and tenacity contribute 13.7% of the variance to the acquisition of mathematics learning achievement. Furthermore, the summary of the regression model and the determination of each coefficient are presented in **Table 6**.

Table 6. Summary of Regression Coefficients and Their Determination

Variable	Coefficient (b)	t	Sig.
Constant	66.725	23.897	0.000
Students' Attitude towards Mathematics	0.039	1.619	0.108
Tenacity	0.078	2.796	0.006

Based on **Table 6**, the regression equation is obtained as follows.

$$Y = 66{,}725 + 0{,}039X_s + 0{,}078X_u \quad (1)$$

Y states the score of students' achievements, X_s states the score of students' attitudes toward mathematics and X_u states the score of students' tenacity. The equation obtained shows that the two predictor variables, namely students' attitude towards mathematics and students' tenacity, positively contributed to students' mathematics learning achievement. This shows that if students' attitudes toward mathematics and their' tenacity increase, students' mathematics learning achievement will also increase. More specifically, if the predictor of students' attitude towards mathematics increases by 1% and the predictor of persistence is constant or zero, students' achievement will increase by 0.039. Otherwise, if the predictor of students' attitude towards mathematics is constant or zero and the predictor of students' tenacity increases by 1%, learning achievement will increase by 0.078. Furthermore, between students' attitudes towards mathematics and tenacity, the tenacity variable significantly impacts the results of students' mathematics learning achievement. This can be seen from the value of t=2.796 with Sig.=0.006 where the value of Sig.=0.006<α=0.05 so that there is a significant impact of tenacity on students' mathematics learning achievement. In the other hand, the value of t=1.619 with Sig.=0.108 were Sig.=0.108>α=0.05 for students' attitude toward mathematics show there is no significant impact on students' mathematics learning achievement. This finding explains that the students' tenacity has better determination to determine students' mathematics learning achievement then students' attitude toward mathematics.

Discussion

The results described descriptively show that most students had a neutral attitude towards mathematics. This is indicated by 70.49% of students were in the neutral category. The same thing happened to the students' tenacity. As many as 83.61% of students were at medium tenacity level. In addition, students with negative attitudes towards mathematics and low tenacity were 0.82% and 1.65%, respectively.

The acquisition of learning achievement in terms of the category of students' attitude towards mathematics had a difference in the average learning achievement, in which students with a positive attitude towards mathematics had the highest average learning achievement (77.79) compared to students with a neutral and negative attitude towards mathematics. Meanwhile, the neutral attitude also had an average learning achievement (77.59), which was higher than the average achievement (74.00) by students with a negative attitude towards mathematics. This indicates there was an impact of students' attitudes on students' achievement.

Similar findings also occurred in the acquisition of students' achievement in terms of students' tenacity. However, the difference in learning achievement is clearer. Students with high tenacity had an average learning achievement (79.56), which was relatively higher than students with medium or low resilience. Meanwhile, students with high tenacity had an average learning achievement (77.74) higher than the average learning achievement (75.00) of students with medium tenacity. This indicates that tenacity had a significant impact on learning achievement.

The results of multiple regression analysis proved that mathematics learning achievement was simultaneously influenced by students' attitudes towards mathematics and students' tenacity. The resulting regression equation showed a positive value on predictors of attitude towards mathematics and student tenacity. This finding explained that there was a positive impact of the two predictor variables on students' achievement. The findings on predictors of students' attitudes towards mathematics are consistent with the findings of Farooq & Shah (2008) and Purnomo (2016), which show that students' attitudes play an important role in the learning process and significantly influence students' mathematics learning achievement.

Furthermore, partially based on statistical tests, it was found that students' tenacity had a significant impact on learning achievement. Meanwhile, in the regression model that was formed, students' attitudes did not have a significant impact. As previously discussed, tenacity is related to resilience, persistence, persistence, and also self-control (Lucas & Spencer, 2018). In several studies, it has been shown that tenacity is positively related to and influences students' achievement (Carbonell, 2017; Mwangi, Okatcha, & Ireri, 2015). Likewise, self-control is positively related to and influences student achievement (Hanifah & Abadi, 2019; Intani & Ifdil, 2018; Judistira & Wijaya, 2017). Further, the persistence in the results of research by Tamardiyah (2017) also influences mathematics learning outcomes and contributes to students' achievement motivation. This illustration explains that tenacity in which students have good resilience, persistence, and self-control will have a significant impact on their learning achievement.

Meanwhile, even though students' attitudes towards mathematics had a positive impact on mathematics learning achievement, the impact was not significant. This is in line with Mubeen, Saeed, & Arif (2013) finding that the correlation between attitude towards mathematics and students' achievement is not significant. This can be caused by several things, such as teaching methods, structural support for schools, families, and student attitudes toward school (Ali et al., 2016). Other factors influencing attitudes toward mathematics include peers and the surrounding community (Mohamed & Waheed, 2011; Yang, 2013). In more detail, attitudes towards mathematics are influenced by teachers' personalities, teacher knowledge, bad instructional practices, and lack of commitment from students and teachers in classroom management (Larsen, 2013; Mensah, Okyere, & Kuranchie, 2013; Prendergast & Hongning, 2016; Yilmaz, Altun, & Olkun, 2010). However, another factor given by Aiken (1970) is related to the specific material, which becomes the context in the research of students' attitudes toward mathematics. Specific factors

of mathematics material become one of the factors that have resulted in several studies showing varied results related to the correlation between students' attitudes towards mathematics and mathematics learning achievement. In this study, the researchers suspected that the insignificant impact of students' attitudes on students' mathematics learning achievement was caused by the geometry transformation material that students were studying when data collection was carried out. Geometry transformation material, as it is known, is one of the materials that have low absorption in the 2017 and 2019 national exams (Puspendik, 2017; Puspendik, 2019). This indicates that geometric transformation material is still seen as a difficult material for students, so it influences students' attitudes towards mathematics (Ali et al., 2016). However, further research is needed to prove the specific impact of mathematics material on students' attitudes towards mathematics.

The results of this study indicate a significant simultaneous effect of students' attitudes towards mathematics and tenacity on mathematics achievement. This has implications for mathematics teachers. Mathematics teachers should be able to design lessons that support the development of students' positive attitudes toward mathematics and high tenacity. However, this study has limitations. One is the mathematics achievement seen in geometric transformation material. This material is seen as difficult by students. In various exams, questions related to this material have low absorption (Sampouw & Retnawati, 2020). Therefore, further research can determine mathematics achievement in other materials.

CONCLUSION

Students' attitude towards mathematics had been studied and turned out to have an impact on students' mathematics learning achievement. This is also in line with students' tenacity. Through this study, it was concluded that students' attitudes toward mathematics and their' tenacity simultaneously had a significant impact on students' achievement. In addition, it was partially found that compared to students' attitudes toward mathematics, tenacity had a significant impact on students' achievement. This implies the need for attention from teachers to not only focus on students' cognitive development, but also students' affective, in this case students' attitude towards mathematics and students' tenacity.

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