Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989 – 9572

DOI: 10.47750/jett.2023.14.05.028

Mathematics Performance as Influenced by Mathematics Anxiety and Self-Efficacy: A Modeling Study

Fresan R. Magnate[1*]

June Rey S. Sulatra[2]

Journal for Educators,Teachers and Trainers, Vol. 14 (5)

https://jett.labosfor.com/

Date of reception: 25 May 2023

Date of revision: 23 June 2023

Date of acceptance: 04 July 2023

Fresan R. Magnate, June Rey S. Sulatra (2023). Mathematics Performance as Influenced by Mathematics Anxiety and Self-Efficacy: A Modeling Study.*Journal for Educators, Teachers and Trainers*,Vol. 14(5). 290-298

[1,2]College of Education, Northern Iloilo State University, Philippines,

Journal for Educators, Teachers and Trainers
The LabOSfor electronic, peer-reviewed, open-access Magazine

Journal for Educators, Teachers and Trainers, Vol. 14 (5)
ISSN 1989 –9572
https://jett.labosfor.com/

Mathematics Performance as Influenced by Mathematics Anxiety and Self-Efficacy: A Modeling Study

Fresan R. Magnate[1*], June Rey S. Sulatra[2]
[1, 2] College of Education, Northern Iloilo State University, Philippines,
*Corresponding author
Email: fresanmagnate@nisu.edu.ph[1],junereysulatra@nisu.edu.ph[2]

ABSTRACT

Some non-cognitive factors influence performance in mathematics. The study explores whether students' self-efficacy and mathematics anxiety influence their performance in mathematics either directly or indirectly. There were 217 grade 12 students in the sample, with 95 (43.78 %) males and 122 (56.2 %) females. The data was gathered using a mathematics anxiety and self-efficacy questionnaire, and the general percentage average in mathematics was used as an indicator of student performance. Using two-stage structural equation modeling, the relationship between students' anxiety and self-efficacy in mathematics and their performance was explored. Anxiety in mathematics and self-efficacy were found to be the two noncognitive con-struct that directly affects mathematics performance as indicated in the model. In addition, the result has noted that there is no correlation between the two noncognitive constructs in mathematics (anxiety and self-efficacy). Based on the findings, it can be concluded that anxiety in mathematics and self-efficacy are two separate noncognitive constructs that have a direct impact on mathematics performance. However, these two constructs do not have any correlation with each other, meaning that one does not influence the other. This implies that addressing anxiety and self-efficacy independently may lead to improved mathematics performance.

Keywords: Mathematics anxiety, Mathematics self-efficacy, Mathematics performance, Structural equation modeling, Modeling

INTRODUCTION

Human resource improvement is needed for a country to develop in all areas and to achieve it, education plays a vital role. In its broadest definition, education can be defined as any activity that has a significant influence on the cognitive, skill, or attitude development of an individual. It is comprised of several different subfields, all of which ought to be introduced to individuals and studied by them. From a global perspective, mathematics is one of the subjects that has been present in every single curriculum of the school. There are already several identified elements that influence the students' progress in mathematics from the previous years of exploration by researchers. This includes anxiety and self-efficacy in mathematics which was identified to have a significant influence towards student achievement in mathematics (Schunk and Mullen, 2012). Moreover, anxiety in mathematics is one of the contributing factors as to why students perform poorly. Between the two factors, self-efficacy was considered to be a more accurate predictor of mathematics performance than mathematics anxiety.

Students in the Philippines must understand and respect mathematical concepts to apply them to tasks such as problem-solving, critical thinking, communication, reasoning, connecting their learnings, and developing visual representations of their ideas to successfully relate their learnings to the actual world. In the general education curriculum (K to 12 Basic Education Curriculum, one of the mandated subjects is mathematics. In the previous International Students Assessment, Philippines performed second to last among the participating nations (DepEd - National Report of the Philippines, 2019). The results are alarming for it means that Filipino students performed significantly worse than the OECD average of 489 points, scoring 353 points on the mathematics literacy scale. According to statistics, only one out of five or 19.7% of Filipino students attained the necessary mathematics literacy competency level (Level 2). Though the mean percent score (MPS) on the National Achievement Test (NAT) for Filipino learners has increased over eight years (2005-2013). However, based on the review report for all national achievement test (NAT) from 2015 in Philippine Education the 75% MPS aim was not achieved. Even though the MPS has increased, still the NAT scores for students in elementary and high school are 6.12% and 23.59% off target.

The common effect of students having negative emotional reactions to mathematics is avoiding courses and activities that need math skills. (Betz & Hackett 1983; Betz 2006). According to Ashcraft (2002), Carey et al. (2016) and Dweck (2006), anxiety in mathematics is a feeling (such as worry, fear, or discomfort) of students that hinders them to perform better in mathematics. In developmental education, one of the recognized important elements that influence the learning, growth and progress in mathematics were anxiety and self-efficacy. Moreover, self-efficacy in mathematics can be described by theories such as implicit theories of intelligence, and theory of entity (Toland & Usher 2016; Usher & Pajares 2009). Due to the lack of readiness shown by students who were graduating from senior high school, one of the most important goals was to increase the mathematical proficiency of students who were enrolling in colleges (Cullinane &Treisman, 2010; Nicoloff, 2018). According to Wolfle's (2012) research, almost 75% of students taking developmental mathematics were unable to pass the course examination. These were shockingly high rates, but unfortunately, they were typical across the country. The attention of those in charge of education was beginning to shift toward the improvement of these success rates as well as the redesigning of developmental education.

Theoretical Background for the Model

The question of how to succeed in mathematics examinations or learn the course gives students worrying feelings which will result in a feeling of anxiety in mathematics learning (Ashcraft & Ridley, 2005). For the students to solve mathematical problems, they need to employ their mathematical abilities such as critical thinking. Individuals need to use their mathematical abilities, which involve critical thinking, to solve mathematical problems (Mammarella et al., 2015; Beilock et al., 2004; Richardson &Suinn, 1972; Ashcraft & Kirk, 2001). Moreover, students who face anxiety in mathematics often exhibit physiological reactions (similar to those associated with pain) and develop negative attitudes towards the subject, leading them to avoid situations that could trigger their anxiety (Young et al., 2012; Chang &Beilock, 2016; Ma, 1999; Ramirez et al., 2018; Ashcraft, 2002; OECD, 2013; Ashcraft & Ridley, 2005; Ashcraft & Moore, 2009; Beasley et al., 2001). According to OECD (2013), in several nations worldwide anxiety in mathematics is a common issue that students experience. Researches noted that anxiety and achievement in mathematics were negatively correlated which implies that the students will perform slightly worse if they experience high anxiety in mathematics (Gunderson et al., 2018; Wang, 2020; Namkung et al., 2019; Chang &Beilock, 2016; Foley et al., 2017; Ma, 1999; Ashcraft & Kirk, 2001; OECD, 2013; Ashcraft & Moore, 2009; Ramirez et al., 2018). The connection between anxiety and self-efficacy in mathematics has been well-established both theoretically and empirically, with substantial evidence revealing a significant relationship between these constructs (Ashcraft, 2002; Pajares & Miller, 1994; Pajares &Kranzler, 1995; Akin &Kurbanoglu, 2011; Jameson, 2014; Griggs et al., 2013). A negative association between the two constructs (anxiety and self-efficacy) in mathematics was noted (Griggs et al., 2013) and anxiety is considered to be more of the physiological source of self-efficacy or anxiety is a significant predictor of self-efficacy (Bandura, 1997; Lopez & Lent 1992) but other studies state the other way around (Pajares &Barich 2005; Pajares 1996; Pajares &Kranzler 1995; Bandura 1986). For example, in the study of Akin &Kurbanoglu (2011) on high school students in the US and Pajares &Kranzler (1995) on undergraduate students in Turkey, self-efficacy in mathematics substantially predicted anxiety in mathematics. Even though there was a literature that supports the predictive relationships of the two constructs (anxiety and self-efficacy) in mathematics to performance in mathematics, it is less clear how these two constructs interact when hypothesized to have a directional effect on performance in mathematics if it is put into a structural model. Thus, the current study explores the relationships among anxiety, self-efficacy, and performance in mathematics. Specifically, it will explore the relationships among these factors through modeling to be more accurate. The models that are based on the hypotheses will take into consideration both direct and indirect influences to achieve this goal. In the researchers' desire to develop a model in which variables are evaluated jointly, it is hypothesized that anxiety and self-efficacy will have a direct effect on one's performance in mathematics and these two constructs are correlated. This is something that should be anticipated because it is reasonable to expect that both variables will have an effect.

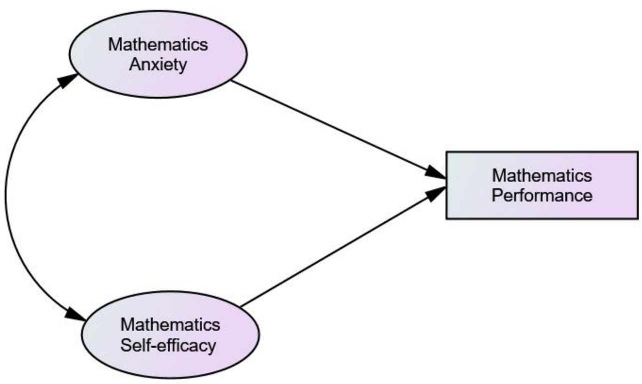

Figure 1: A hypothesized model of anxiety, self-efficacy, and performance in mathematics

METHOD

Research Design

This study aimed to explore the relationships among anxiety, self-efficacy, and performance in mathematics. The researchers utilized Co-variance Based Structural Equation Modeling (CB-SEM) design to construct a model in which both variables are evaluated jointly. CB-SEM compares observed and proposed covariance matrices to assess the fit of the causal model (Lowry & Gaskin, 2014). SEM is a quantitative research method that also allows for the use of qualitative techniques. Typically, SEM is used to visualize and validate numerous statistical correlations concurrently (Dash & Paul, 2021). Moreover, Sarstedt et al. (2017), Hair Jr et al. (2017), and Haenlein& Kaplan (2004) described structural equation modeling (SEM) as the simultaneous use of multiple regression and factor analysis. SEM replaces "dependent" and "independent" variables with "exogenous" and "endogenous" variables in analyses. Exogenous variables are always independent, while endogenous variables can be dependent or independent in different parts of the model. SEM involved different measurements which will provide an understanding of how latent constructs (factors) interacts. Analyzing the structure of the covariance also goes by the term's latent variable analysis and analysis of the covariance. A confirmatory strategy, as opposed to an exploratory one, is used in this research.

Sample

Sample size determined based on Wolf et al.'s (2013) recommendation. Sample sizes varied from 30 to 460, depending on the number of factors and indicators, and their corresponding loadings. The 10 cases per variable rule resulted in sample size recommendations ranging from 40 to 240.

Originally, the respondents were 300 randomly selected Grade 12 study but was reduce to 217 students from seven national high schools in Western Visayas, Philippines due some suggestions during the preliminary analysis of the data. These composes of 95 (43.78%) male students and 122 (56.2%) female.

Instruments

The Mathematics Self-efficacy and Anxiety Questionnaire ((MSEAQ) of Daina K. May-Swanagan (2009) was utilized. It is a 29-item Likert scale question in which respondents check the appropriate column of 1 (Never), 2 (Seldom), 3 (Sometimes), 4 (Often), and 5 (Usually). Anxiety items are scored reversely.From the present study's context, the scale is valid for both anxiety and self-efficacy in mathematics. The internal consistency coefficients for anxiety and self-efficacy were found to be 0.73 and 0.79, respectively. The model fit indices in a confirmatory factor analysis (CFA) indicating excellent fit (χ^2/df = 1.055, Standard Root Mean Square Residual (SRMR) = 0.067, Root Mean Square Error of Approximation (RMSEA) = 0.016, PClose = 1.000, and Comparative Fit Index (CFI) = 0.980).

The data that was used to determine the student's overall mathematics performance was the student's general percentage average in mathematics from the first quarter through the fourth quarter.

Data Analysis

After the data were collected from the sample (n = 217), The preliminary analysis for SEM such as checking the missing data, and outliers, and testing the normality, linearity, homoscedasticity, and multicollinearity of the data was conducted. The structural model was used to determine if the proposed is suitable to describe the data. To evaluate the model fit, absolute indices such χ^2, χ^2/df, Standard Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), PClose = 1.000, and Comparative Fit Index (CFI) were calculated as goodness-of-fit indices for SEM analysis.

Goodness-of-fit indices were used to evaluate model fit in the measurement model for CFA and structural model, based on the criteria suggested by the authors. The study used established criteria for model fit: CMIN/df< 5 (Wheaton, 1987), CFI should be 0.95 (Hu &Bentler, 1999; Schreiber et al., 2006). To indicate close fit, the model should have SRMR and RMSEA values less than 0.08 (Hu &Bentler, 1999; Browne &Cudeck, 1993). Pclose should be greater than 0.05 (Gaskin & Lim 2016).

Ethical Considerations

Before implementing the study, formal consent from school heads or administrators was secured. The participation of identified respondents was entirely voluntary. In addition, the parents of students in 12th-grade classes granted their full consent to participate in the study. The research respondents were informed of the aims of the study, and safeguards were taken to ensure that they were not coerced or harmed in any way during the study. All data collected was treated with strict confidentiality and was utilized solely for the research.

FINDINGS

Based on the Pearson correlation coefficients, Table 1 shows that anxiety in mathematics and self-efficacy were directly related to performance in mathematics at the 0.01 significance level. However, there was no evidence to suggest that the two noncognitive constructs (anxiety and self-efficacy) in mathematics are related to one

another. Moreover, the variables are normally distributed because the values of skewness and kurtosis were contained within the range of -1 to 1.
As can be observed in Table 1, there were small positive correlations between performance and anxiety (r = 0.19, p = 0.006) . Similarly, a small positive correlation perfomance and self-efficacy (r = 0.23, p = 0.001). Additionally, it was noted that self- anxiety and self-efficacy are not correlated (r = 0.05, p = 0.498)

Table 1: Descriptive Information about the Variables contained in the Model and a Correlation Matrix

		Mathematics Performance	Mathematics Anxiety	Mathematics Self-efficacy
Mathematics Performance	r	1	.19**	.23**
	p		.006	.001
Mathematics Anxiety	r		1	.05
	p			.498
Mathematics Self-efficacy	r			1
	p	.		
M		87.55	3.09	2.95
SD		4.21	0.46	0.33
Skewness		0.01	-0.01	0.15
Kurtosis		-0.74	-0.05	-0.27

The estimated model fit indices were tested (see Figure 2), and acceptable to excellent fit indices (χ^2/df = 1.642, p < .01, CFI = 0.912, SRMR = 0.079, RMSEA = 0.049, and PClose = 0.557) were found (see Table 3) (Gaskin, J. & Lim, J., 2016).

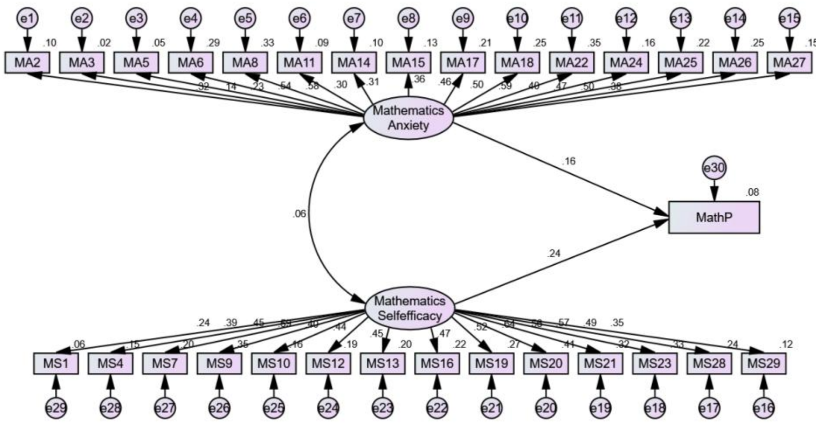

Figure 2: Standardized Parameter Estimates of the Structural of the hypothesized Model

Table 2: Fit Indices of Hypothesized Model (Model A)

χ^2	Df	χ^2/df	p	CFI	SRMR	RMSEA	PClose
611.821	403	1.642	p<.01	0.912	0.079	0.049	0.557

Table 3 shows the hypothesized model (Model A) maximum likelihood estimates (Regression Weights). All of the p values were significant (p < 0.05) as shown. In absolute values of 0.572 and 0.511, the likelihood of getting a critical ratio for anxiety and self-efficacy in mathematics to performance was as high as 2.395 and 3.376, respectively. In other words, at the 0.05 level, the regression weight for anxiety and self-efficacy in mathematics in the prediction of performance in mathematics differs from zero (two-tailed). This imply that anxiety and self-efficacy in mathematics have a significant influence on the prediction of performance in mathematics. Higher levels of anxiety may be associated with lower performance, while higher levels of self-efficacy in mathematics may be associated with higher performance. However, the covarying path between anxiety and self-efficacy in mathematics was not significant (p=.717). It means that the covariance between anxiety and self-efficacy in mathematics is not significantly different from zero at the 0.05 level (two-tailed). This also suggest that no significant relationship exists between anxiety and self-efficacy in mathematics in the model. The absence of significant covariation does not imply no relationship between variables. This only suggest that in the model, the correlation between anxiety and self-efficacy in mathematics is not significant.

The absence of a significant correlation between anxiety and self-efficacy in mathematics does not invalidate diminish the importance of their individual regression weights in predicting math performance. The variables have independent regression weights that contribute to predicting mathematics performance, despite their lack of significant correlation.

Table 3: Maximum Likelihood Estimates (Regression Weights) for the Hypothesized Model (Model A)

Regression/ Covarying paths	Estimate	S.E	C.R	p
Mathematics Performance ⟵ Mathematics Anxiety	1.369	0.572	2.395	.017
Mathematics Performance ⟵ Mathematics Self-efficacy	1.726	0.511	3.376	p<.001
Mathematics Anxiety ⟷ Mathematics Self-efficacy	0.011	0.031	0.363	.717

Following the recommendations of the Maximum Likelihood Estimate, we applied all of the potential covariance modification indices and got rid of the paths that weren't significant (Regression Weight). The value of the model test statistics as well as the approximate fit indices for the hypothesized recursive path model of Anxiety, Self-efficacy, and Performance in mathematics have seen a significant increase.

Model Generating, Testing and Comparing

The modified model (Model A) has achieved excellent fit indices (see Figure 1), and (x^2/DF = 1.132, p = .040, CFI = 0.950, SRMR = 0.069, RMSEA = 0.025, and PClose = 1.000) were found (Gaskin, J. & Lim, J., 2016). Another model (Model B) was also tested and was to be an equivalent model of Model A (see Figure 3) for having the same fit indices (x^2/DF = 1.132, p = .040, CFI = 0.950, SRMR = 0.069, RMSEA = 0.025, and PClose = 1.000). The parsimony fit indices of Model A (AIC=605.329, BIC=912.900) and Model B (AIC=605.329, BIC=912.900) indicated that these two models are equivalent. However, Model B was the better model that describes the data because all the regression paths were significant while Model A has nonsignificant covarying paths.

Table 4: Fit Indices of Model A and B

Model	χ^2	Df	χ^2/df	p	CFI	SRMR	RMSEA	PClose	AIC	BIC
A	423.329	374	1.132	P=.04	0.950	0.069	0.025	1.000	605.329	912.900
B	423.329	374	1.132	P=.04	0.950	0.069	0.025	1.000	605.329	912.900

Table 5 shows Model B maximum likelihood estimates (Regression Weights). All of the p values were significant (p <0.05) as shown. The results indicated that, when mathematics anxiety increases by 1 unit, mathematics performance increases by 1.384 units. The standard error associated with this estimate is 0.573. Similarly, when mathematics self-efficacy increases by 1 unit, mathematics performance increases by 1.740 units, with a standard error of 0.512. The regression weights and standard errors reveal the strength and accuracy of the relationships between predictor variables (mathematics anxiety and self-efficacy) and the outcome variable (mathematics performance). The p-values suggest that the connections among mathematics anxiety, mathematics self-efficacy, and mathematics performance are statistically significant. Mathematics anxiety and self-efficacy significantly predict mathematics performance.

Table 5: Maximum Likelihood Estimates (Regression Weights) Model B

Regression paths	Estimate	S.E	C.R	p
Mathematics Performance ⟵Mathematics Anxiety	1.384	0.573	2.415	.016
Mathematics Performance ⟵Mathematics Self-efficacy	1.740	0.512	3.401	p<.001

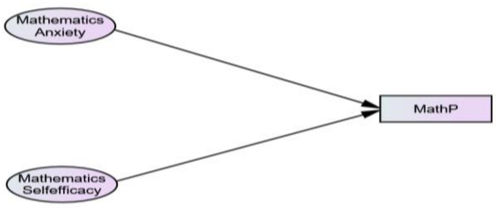

Figure 3: Model B

DISCUSSION

This study investigated the directional effects of anxiety and self-efficacy on performance in mathematics. Based on the previous research findings it was hypothesized that anxiety and self-efficacy in mathematics were related to one another and both have a direct effect on performance in mathematics. As reflected in the modified model, both anxiety and self-efficacy in mathematics had direct effects on performance in mathematics, and these two noncognitive constructs (anxiety and self-efficacy) predicted the performance consistently (Schunk & Mullen, 2012). In addition, self-efficacy in mathematics is a more accurate predictor of performance than anxiety and a negative correlation between anxiety and performance in mathematics was noted (Watts, 2011; Suhas, & Pandya, 2016). The researchers have also observed that the correlations among variables (anxiety, self-efficacy, and performance in mathematics) are more complex than it initially appears to be (Ashcraft & Moore, 2009).

Even though the model shows a relationship between the two noncognitive constructs (anxiety and self-efficacy), these two constructs are unrelated. The most significant independent variable determining self-efficacy perceptions about teaching mathematics, according to the literature, is mathematics anxiety. A negative linear connection between the two noncognitive constructs is supported by literature it was not confirmed in this study, which means that as anxiety in mathematics drops, the self-efficacy of the students about teaching mathematics rise is not supported by the results of this study (Unlu, Ertekin, &Dilmac 2017; Nicoloff, 2018). This study did not corroborate the cause-and-effect relationship suggested by the model, in which a low level of anxiety leads to increased levels of self-efficacy; however, previous research supports the hypothesis.

CONCLUSION

This study makes a significant contribution to the creation of more complete theories that highlight how mathematics anxiety and self-efficacy influence mathematics performance. Although additional research needs to be done, this study contributes significantly to the creation of more complete theories. According to the model, anxiety and self-efficacy in mathematics are two noncognitive constructs that determine how well someone does in mathematics. This study rejected the hypothesis that self-efficacy and mathematical anxiety are related. Additional studies are needed that can add to the growing body of evidence-based literature which can be used to design educational environments that are supportive of the development of successful programs that lower anxiety and raise self-efficacy in mathematics, assuming that both have a significant impact on students' performance in mathematics.

REFERENCES

1. Akin, A., &Kurbanoglu, I. N. (2011). The relationships between math anxiety, math attitudes, and self-efficacy: A structural equation model. Studia Psychologica, 53(3), 263.
2. Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. Current directions in psychological science, 11(5), 181-185. https://doi.org/10.1111/1467-8721.00196
3. Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. Journal of experimental psychology: General, 130(2), 224. https://doi.org/10.1037/0096-3445.130.2.224
4. Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. Journal of Psychoeducational assessment, 27(3), 197-205. https://doi.org/10.1177/0734282908330580
5. Ashcraft, M. H., & Ridley, K. S. (2005). Math anxiety and its cognitive consequences. Handbook of mathematical cognition, 315-327.
6. Bandura, A. (1986). Social foundations of thought and action. Englewood Cliffs, NJ, 1986(23-28).
7. Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.
8. Beasley, T. M., Long, J. D., & Natali, M. (2001). A confirmatory factor analysis of the mathematics anxiety scale for children. Measurement and Evaluation in Counseling and Development, 34(1), 14-26. https://doi.org/10.1080/07481756.2001.12069019
9. Beilock, S. L., Kulp, C. A., Holt, L. E., &Carr, T. H. (2004). More on the fragility of performance: choking under pressure in mathematical problem solving. Journal of Experimental Psychology: General, 133(4), 584. https://doi.org/10.1037/0096-3445.133.4.584
10. Betz, N. E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. Journal of Vocational behavior, 23(3), 329-345.
11. Betz, N. E., & Hackett, G. (2006). Career self-efficacy theory: Back to the future. Journal of career assessment, 14(1), 3-11. https://doi.org/10.1177/1069072705281347

12. Carey, E., Hill, F., Devine, A., &Szücs, D. (2016). The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. Frontiers in psychology, 1987. https://doi.org/10.3389/fpsyg.2015.01987
13. Chang, H., &Beilock, S. L. (2016). The math anxiety-math performance link and its relation to individual and environmental factors: A review of current behavioral and psychophysiological research. Current Opinion in Behavioral Sciences, 10, 33-38. https://doi.org/10.1016/j.cobeha.2016.04.011
14. Cullinane, J., &Treisman, P. U. (2010). Improving Developmental Mathematics Education in Community Colleges: A Prospectus and Early Progress Report on the Statway Initiative. An NCPR Working Paper. National Center for Postsecondary Research.
15. Dash, G., & Paul, J. (2021). CB-SEM vs PLS-SEM methods for research in social sciences and technology forecasting. Technological Forecasting and Social Change, 173, 121092. https://doi.org/10.1016/j.techfore.2021.121092
16. Department of Education. (2019). PISA 2018 National Report of the Philippines. https://www.deped.gov.ph/wp-content/uploads/2019/12/PISA-2018-Philippine-National-Report.pdf
17. Dweck, C. S. (2008). Mindset: the new psychology of success. New York: Random House, Inc.
18. Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., &Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. Current Directions in Psychological Science, 26(1), 52-58. https://doi.org/10.1177/0963721416672463
19. Gaskin, J. & Lim, J. (2016), "Model Fit Measures", AMOS Plugin. Gaskination'sStatWiki.
20. Griggs, M. S., Rimm-Kaufman, S. E., Merritt, E. G., & Patton, C. L. (2013). The Responsive Classroom approach and fifth grade students' math and science anxiety and self-efficacy. School Psychology Quarterly, 28(4), 360. https://doi.org/10.1037/spq0000026
21. Gunderson, E. A., Park, D., Maloney, E. A., Beilock, S. L., & Levine, S. C. (2018). Reciprocal relations among motivational frameworks, math anxiety, and math achievement in early elementary school. Journal of Cognition and Development, 19(1), 21-46. https://doi.org/10.1080/15248372.2017.1421538
22. Haenlein, M., & Kaplan, A. M. (2004). A beginner's guide to partial least squares analysis. Understanding statistics, 3(4), 283-297. https://doi.org/10.1207/s15328031us0304_4
23. Hair Jr, J. F., Matthews, L. M., Matthews, R. L., &Sarstedt, M. (2017). PLS-SEM or CB-SEM: updated guidelines on which method to use. International Journal of Multivariate Data Analysis, 1(2), 107-123. https://doi.org/10.1504/IJMDA.2017.087624
24. Jameson, M. M. (2014). Contextual factors related to math anxiety in second-grade children. The Journal of Experimental Education, 82(4), 518-536. https://doi.org/10.1080/00220973.2013.813367
25. Lopez, F. G., & Lent, R. W. (1992). Sources of mathematics self-efficacy in high school students. The career development quarterly, 41(1), 3-12. https://doi.org/10.1002/j.2161-0045.1992.tb00350.x
26. Lowry, P. B., & Gaskin, J. (2014). Partial least squares (PLS) structural equation modeling (SEM) for building and testing behavioral causal theory: When to choose it and how to use it. IEEE transactions on professional communication, 57(2), 123-146. 10.1109/TPC.2014.2312452.
27. Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. Journal for research in mathematics education, 30(5), 520-540. https://doi.org/10.2307/749772
28. Mammarella, I. C., Hill, F., Devine, A., Caviola, S., &Szűcs, D. (2015). Math anxiety and developmental dyscalculia: A study on working memory processes. Journal of clinical and experimental neuropsychology, 37(8), 878-887. https://doi.org/10.1080/13803395.2015.1066759
29. May, D. K. (2009). Mathematics self-efficacy and anxiety questionnaire (Doctoral dissertation, University of Georgia).
30. Namkung, J. M., Peng, P., & Lin, X. (2019). The relation between mathematics anxiety and mathematics performance among school-aged students: A meta-analysis. Review of Educational Research, 89(3), 459-496. https://doi.org/10.3102/0034654319843494
31. Nicoloff, A. E. (2018). Mathematics Anxiety and Attitudes as Predictors of Mathematics Self-Efficacy in Developmental Mathematics Courses. ProQuest LLC.

32. Organisation for Economic Co-operation and Development (OECD). (2013). PISA 2012 Results: Ready to Learn: Students' Engagement, Drive and Self-Beliefs (Volume III): Preliminary Version. Paris, France: OECD.
33. Pajares, F. (1996). Self-efficacy beliefs in academic settings. Review of educational research, 66(4), 543-578. https://doi.org/10.3102/00346543066004543
34. Pajares, F., &Barich, J. (2005). Assessing mathematics self-efficacy: Are skills-specific measures better than domain-specific mesures?. Psychology: The Journal of the Hellenic Psychological Society, 12(3), 334-348.
35. Pajares, F., &Kranzler, J. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. Contemporary educational psychology, 20(4), 426-443. https://doi.org/10.1006/ceps.1995.1029
36. Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. Journal of educational psychology, 86(2), 193. https://doi.org/10.1037/0022-0663.86.2.193
37. Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. Educational Psychologist, 53(3), 145-164. https://doi.org/10.1080/00461520.2018.1447384
38. Richardson, F. C., &Suinn, R. M. (1972). The mathematics anxiety rating scale: psychometric data. Journal of counseling Psychology, 19(6), 551. https://doi.org/10.1037/h0033456
39. Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial least squares structural equation modeling. In Handbook of market research (pp. 587-632). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-57413-4_15
40. Schunk, D. H., & Mullen, C. A. (2012). Self-efficacy as an engaged learner. In Handbook of research on student engagement (pp. 219-235). Springer, Boston, MA. https://doi.org/10.1007/978-1-4614-2018-7_10
41. Suhas, P. S., & Pandya, S. (2016). Factors Influencing Students' Academic Performance in Mathematics. Educational Quest, 7(3), 291. 10.5958/2230-7311.2016.00050.7
42. Toland, M. D., & Usher, E. L. (2016). Assessing mathematics self-efficacy: How many categories do we really need?. The Journal of Early Adolescence, 36(7), 932-960. https://doi.org/10.1177/0272431615588952
43. Unlu, M., Ertekin, E., &Dilmac, B. (2017). Predicting Relationships between Mathematics Anxiety, Mathematics Teaching Anxiety, Self-Efficacy Beliefs towards Mathematics and Mathematics Teaching. International Journal of Research in Education and Science, 3(2), 636-645. 10.21890/ijres.328096
44. Usher, E. L., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. Contemporary educational psychology, 34(1), 89-101. https://doi.org/10.1016/j.cedpsych.2008.09.002
45. Wang, L. (2020). Mediation relationships among gender, spatial ability, math anxiety, and math achievement. Educational Psychology Review, 32(1), 1-15. https://doi.org/10.1007/s10648-019-09487-z
46. Watts, B. (2011). Relationships of Mathematics anxiety, Mathematics self-efficacy and Mathematics performance of Adult Basic Education Students (Publication No. 3449398) [Doctoral dissertation, Capella University]. ProQuest Dissertation and Theses Global.
47. Wolf, E. J., Harrington, K. M., Clark, S. L., & Miller, M. W. (2013). Sample size requirements for structural equation models: An evaluation of power, bias, and solution propriety. Educational and psychological measurement, 73(6), 913-934. https://doi.org/10.1177/0013164413495237.
48. Wolfle, J. D. (2012). Success and persistence of developmental mathematics students based on age and ethnicity. The Community College Enterprise, 18(2), 39.
49. Young, C. B., Wu, S. S., & Menon, V. (2012). The neurodevelopmental basis of math anxiety. Psychological science, 23(5), 492-501. https://doi.org/10.1177/0956797611429134