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Differential Model of Mathematics Anxiety between Male and Female Students in a State University

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ABSTRACT

Anxiety is long believed to impede the mathematics teaching – learning process not only in the foundation years of education but throughout the academic journey of both male and female students. Thus, this research was conducted primarily to identify the personal and environmental predictors of mathematics anxiety among male and female university students and compare their anxiety models. There were 340 students in a state university in the Philippines who were considered as respondents. The data gathered were analyzed using descriptive-correlational design, multiple linear regression, and discriminant analyses. Negative and weak correlations existed between males' year level and math subjects were taken, and math anxiety as well as female's year level and anxiety which means that the higher is the year level, the lesser is the anxiety, of both sexes and the more math subjects taken by males, the lesser is their math anxiety. Various discriminating variables led to differences between mathematics anxiety models of male and female students.

Keywords: mathematics, emotion anxiety, assessment/test anxiety, environment anxiety, mathematics anxiety, discriminant analysis

INTRODUCTION

Over the past decades, researchers emphasized studies that dealt with developments in mathematics education and the assessment of mathematical knowledge and competencies with various testing methods. While countries and schools continuously compare their results, hoping to top the charts, there is also a growing awareness about millions of individuals who struggle with mathematics (Boaler, 2016). One of these struggles is mathematics anxiety.

Mathematics anxiety is a universal fact. It is a feeling of being uncomfortable when performing mathematical tasks. This is believed to affect a notable proportion of school learners' population (Devine et al., 2012) and whose self-esteem is threatened (Zettle & Raines, 2000). From a social cognitive perspective, anxiety is a state of anticipatory apprehension over possible detrimental occurrences. In such cases, self-efficacy has a crucial role (Bandura in Lavasani et al., 2011). Experts claim that math anxiety brings extensive intergenerational discomfort with the subject making mathematics and science careers less appealing and less interesting (Sparks, 2011; Alday & Panaligan, 2013; Mutodi & Ngirande, 2014). Even though college courses in mathematics are transitioning students' conceptions and ways of thinking, which means learners learn the requisite subject content-knowledge relative to other academic pursuits (Code et al., 2015), mathematics anxiety continues to disturb many, which makes it a trending theme in various researches and studies for over the years.

In South Africa, students from many schools, including tertiary institutions, faced an extreme fear in mathematics called math phobia. Malaysia, which works to be a fully developed country by 2020, emphasizes science, mathematics, and technology in its educational system. However, mathematics performance was still an issue even in primary schools. Mathematics was regarded as a killer paper that is difficult to learn and hard to pass. These negative ideas towards the subject contributed much to mathematical anxiety (Wahid et al., 2014). In Egypt, math anxiety was prevalent among college campuses (Khatoon & Mahmood, 2010). In the United States, about 33% of Americans were reported to possess the fear of math (Abo Hamza & Helal, 2013), making it difficult for them to calculate the difference between two numbers found in a bar graph, the cost of three tickets in a game or the total price of purchase (Greenberg & Jin, 2007). Studies also showed that in many learning institutions, the affective components of learning, such as anxiety, were often ignored, which became why many students never

developed a solid foundation in basic mathematics (Mutodi & Ngirande, 2014).

The Philippines is not an exemption to this phenomenal problem. Researches unfold that the underachievement of Filipino learners in mathematics can be sketched out from the difficulty of learning math concepts and a congested curriculum in Math. This may also be caused by flimsy foundations of students in the fundamental skills and absence of decent school facilities (Laguador, 2013; Lee-Chua, 2005). However, this underachievement can be blamed more on the negative attitudes and stereotypes of Filipinos toward the subject (Lee-Chua, 2005). It has become a trend and a common fact, that many college students choose courses based on the number of mathematics subjects since math is considered difficult (Alday & Panaligan, 2013).

Deficit Theory by Eller attempts to elaborate on why certain disadvantaged individuals are likely to fail in school. It illustrates that some students are more prone to achieve academic success than others. It also suggests that people who initially have poor performance were more likely to develop mathematics anxiety, interfering with the learners cognitively. It distracts their thoughts and sensations, which consequently distracts their memory capacity. Those individuals with mathematics anxiety work very poorly in questions that require a high level of working memory (Carey et al., 2016).

Over the years, several studies have been carried out, which postulated the causes and predictors of mathematics anxiety. A great amount of math anxiety was equated with threefold test anxiety-like poor test-taking strategies, poor test preparation, and psychological pressures (Arem, 2003). Math anxiety was also linked to prior negative math experiences like having been punished by present or past teachers because of failure to solve or understand math concepts, having a bad grade in math, lack of encouragement from parents or teachers, and lack of positive role models. These negative experiences with math often resulted in a lack of understanding of a subject (Abo Hamza & Helal, 2013). Difficulty with math may also contribute to math anxiety (Maloney et al., 2011; Maloney et al., 2010; Núñez-Peña & Suárez-Pellicioni, 2015), which means that a poor grasp of basic math concepts may predispose learners to develop anxiety in response to their math struggles (Levine et al., 2015). Another research postulated that math anxiety was attributed to test anxiety, students' perceptions of high school math teachers' ability, parental support for math skills, length of time since completing high school, number of college math classes taken, perceived math ability and gender (Haynes et al., 2004).

Mathematics anxiety can also be blamed for self-doubt and self-depreciation

(Zhang, 2004). Students with math anxiety possess little or no confidence in their ability to solve math problems (Ashcraft & Kirk, 2001). Teachers also were contributory to the development of math anxiety among learners. They also played an important role in the prevention and reduction of this anxiety through focusing instructional practice on mastery rather than on performance (Furner & DeHass, 2011). Potential factors on the occurrence of mathematics anxiety may include environmental variables (negative experiences in class, teacher characteristics), intellectual variables (degree of abstract or logical thinking), and personality variables (self-esteem, learning style, attitude, and confidence) (Yuksel – Sahin, 2008).

While there is an abundance of researches conducted pertaining to the causes of mathematics anxiety, there is still a dearth of knowledge regarding the development of anxiety in the general population (Madjar et al., 2016), especially among students in universities and colleges. Further, there have been no local researches conducted that focused on the differential model of mathematics anxiety between sex groups which is needed to determine the discriminating factors causing anxiety. In a state university in Quirino, Cagayan Valley, there were studies carried out relating to mathematics anxiety, but a comparison on models of anxiety among students have not been documented. Therefore, academicians, students, and all other people directly or indirectly affected by mathematics anxiety can benefit from understanding its possible predictors and antecedents as this gives them preliminary data so they can seek out innovative approaches to lessen or even eliminate this phenomenal problem. Hence, this study was undertaken.

FRAMEWORK

To check influence of environmental and personal factors, the researcher drew the conceptual framework as a guide in the conduct of the study. The particular interest in this study was to estimate the degree of how much environmental and personal factors or variables mediate in determining the difference in mathematics anxiety models of male and female SUC students.

It was hypothesized that male and female SUC students vary on the level of their mathematics anxiety. There may probably be similarities in their anxiety levels, but this was not the focus of this research. The anxiety of students was believed to be somewhat influenced by some environmental and personal variables.

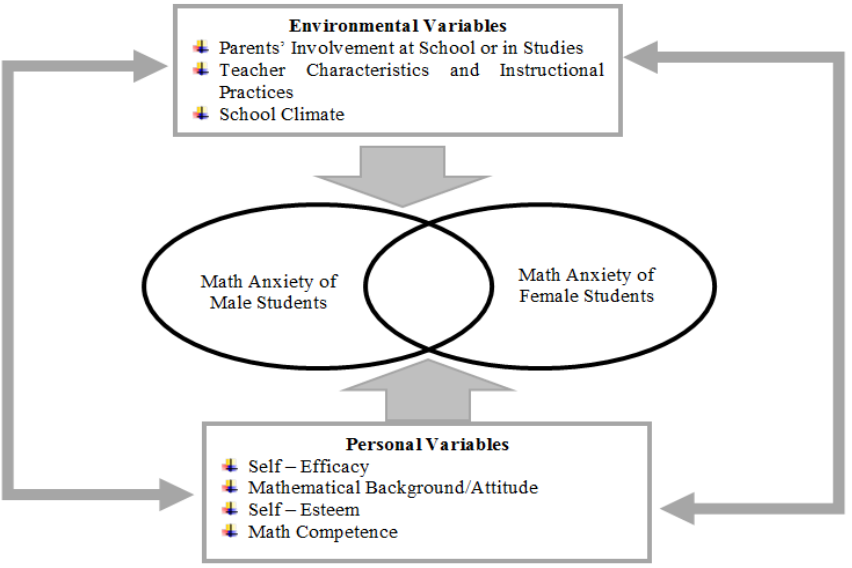

Figure 1. Conceptual framework showing the hypothesized result of the study.

These environmental and personal variables were believed to have predicted the mathematics anxiety of students and had created differences in the models of anxiety between male and female groups. After analysis, a differential model of mathematics anxiety was created to portray variations of variables that influence each sex group's mathematics anxiety.

OBJECTIVES OF THE STUDY

This study primarily aimed at identifying the discriminating factors causing mathematics anxiety of both and female state university students. Specifically, it shed light to the following objectives: (1) find out the level of mathematics anxiety of students grouped according to sex along with emotion, assessment/test and environment anxiety, (2) determine the existence of a significant correlation of mathematics anxiety and profile, (3) identify the discriminators of male and female anxiety.

METHODS

The study conducted was descriptive - correlational integrating discriminant analysis. The descriptive design allowed the researcher to create a snapshot of the current mathematics anxiety level of male and female university students and to build opportunities for the development of queries for further study. It also assessed relationships between mathematics anxiety and variables like environment and personal factors predicting anxiety. Several discriminators of mathematics anxiety among male and female students were also identified using the research design used. Among the variables considered include profile variables like sex, age, course is taken, year level and a number of math subjects taken; math anxiety (emotion, assessment, and environment) and evaluations on the environment (involvement of parents in studies or school, teacher characteristics, and instructional practices and school climate) and personal variables (general self-efficacy, mathematical background or attitude, self-esteem, and math confidence).

. Three hundred forty respondents (160 male and 180 female) were suggested by G*Power in order to have $\alpha = 0.05$ and $\beta = 95\%$ accuracy. These students were proportionately taken from the different campuses of the state university in Cagayan Valley, Philippines. Based on their profile, the average age of respondents was 21.24 years old. Hence, the respondents were characteristically young and were in their early years in college. They were distributed from among the different courses or programs offered in the three campuses of the university. Almost half of the students were enrolled in education or criminology courses. The majority of them were enrolled in their early years in college as freshmen or sophomores. The average number of math subjects in college finished by the respondents was three (3).

The researcher made use of a survey questionnaire as the primary data gathering instrument to be able to attain the objectives of the study. The survey was cross-sectional. It was adapted from various sources and authors of researches conducted regarding mathematics anxiety and related researches. It has undergone critiquing and review of experts to ensure that items included fit the objectives of the study and are error free. After the experts' evaluation, it was subjected to pilot-testing to several students (non-respondents) to guarantee that they understand the items. Based on the responses of students, it was tested using Cronbach's alpha coefficient to measure reliability and was found to be fitted for the study.

Data gathered were analyzed using appropriate statistical tools. Frequency

counts, percent, mean, Pearson Product Moment Correlation Coefficient, Multiple Linear Regression, and Discriminant Analysis were used as statistical treatments.

RESULTS AND DISCUSSION

Table 1

Mathematics Anxiety Level of Male and Female University Students

Mathematics Anxiety	Sex	Mean	Description
Emotion	Male	2.24	Moderate
	Female	2.40	Moderate
Assessment/Test	Male	2.57	High
	Female	2.67	High
Environment	Male	2.31	Moderate
	Female	2.51	High
Overall Mathematics Anxiety	Male	2.37	Moderate
	Female	2.53	High

Male and female students were found to have moderate mathematics emotion anxiety, which means that they felt emotionally incapable of doing activities that involved mathematics. Sometimes they got tensed or had fear in a mathematics class. Numerically, female students possessed higher emotion anxiety compared to their male counterparts. This agrees with Tobias and Weissbrod (1999) in Mutodi and Ngirande (2014); anxiety brings panic, helplessness, paralysis, and mental disorganization when solving mathematical problems. That anxiety is a state of panic which influences thoughts when one is confronted with various concepts and problems in mathematics (Bisse in Abo Hamza & Helal, 2013). When someone possesses anxiety, he feels uneasy and uncomfortable when doing mathematical tasks (Devine et al., 2012). Further, these literature imply that one's emotion is affected by mathematics anxiety.

Both male and female students have high anxiety towards mathematics assessment or test as given, which implies that students feel incapable of taking mathematical tests, which interfere with their ability to learn the subject. They often get tensed, apprehended, or are fearful in a mathematics class which leads to avoidance of the subject. Anxiety can be attributed to taking mathematics tests (Haynes et al., 2004). Further, test anxiety, according to Kendra (2012) in Reyes and Castillo (2015), was known to work in the cycle; that is, after experiencing test anxiety on one test, the student may become fearful of taking other tests. If this was not addressed, the student becomes helpless in the situation. The

findings also support the study of Smith (2004) in Mutodi and Ngirande (2014), which revealed that students possess anxiety when they know that a test or task was coming.

Male respondents possess moderate environment anxiety, while female students have high environment anxiety. Having high anxiety gives the feeling that one is incapable of performing math activities which leads to interfering with one's ability to learn the subject. Being tense and apprehended about mathematics often lead to avoidance of the subject. Based on research by Aarnos and Perkkila (2012), mathematics anxiety may be influenced by an environmental factors. The negative experience of parents or teachers in mathematics may affect their children and cause them to throw negative attitudes and beliefs towards the subject.

In general, male students generally possessed moderate math anxiety while female students have high anxiety towards the subject. This confirms the research result of Posamentier et al. (2013) in Mutodi and Ngirande (2014), where most students' anxiety levels range from moderate to high. A moderate level of anxiety was believed to facilitate performance, while beyond this point, it became counterproductive to mental tasks and conceptual procedures.

Table 2

Correlation between Profile and Mathematics Anxiety

Profile	Sex	Pearson r	Sig
Age	Male	-0.111	0.160
	Female	-0.023	0.761
Course	Male	0.141	0.075
	Female	0.073	0.328
Year Level	Male	-0.166*	0.036
	Female	-0.225*	0.002
Number of Math Subjects Taken	Male	-0.183*	0.021
	Female	-0.136	0.068

Note. *significant at 0.05 level

Results showed that the year level of both sexes was significantly correlated to their anxiety, while the number of subjects taken by male students was significantly associated with anxiety. Correlations are found to be negative and weak. This implies that as a male and female student escalates in higher education, their mathematics anxiety is somewhat reduced; as a male student enrolls more math in college, his anxiety towards the subject is decreased. This is similar to a study

which revealed that anxiety and math course taken were related. Math-anxious students took fewer math courses and avoided elective math coursework as early as a secondary school (Ashcraft & Moore, 2009).

However, the ages and courses of both male and female students did not significantly correlate with their mathematics anxiety. This implies that age and course did not significantly cause the mathematics anxiety of students. Thus, these profile variables cannot predict mathematics anxiety among male and female college students.

Table 3

Correlation between Environmental and Profile, and Mathematics Anxiety

Profile	Environmental Variables	Sex			
		Male		Female	
		Pearson r	Sig	Pearson r	Sig
Age	Parents' Involvement on Studies or in School	-0.118	0.139	-0.136	0.068
	Teachers' Characteristics and Instructional Practices	0.113	0.155	0.093	0.213
	School Climate	0.112	0.159	0.217*	0.003
Course	Parents' Involvement on Studies or in School	0.062	0.437	0.167*	0.025
	Teachers' Characteristics and Instructional Practices	0.030	0.703	0.019	0.798
	School Climate	-0.014	0.398	0.038	0.613
Year Level	Parents' Involvement on Studies or in School	-0.217*	0.006	-0.133	0.075
	Teachers' Characteristics and Instructional Practices	-0.002	0.977	0.008	0.075
	School Climate	-0.026	0.741	0.090	0.228
No. of Math Subjects	Parents' Involvement on Studies or in School	-0.154	0.053	-0.145	0.052
	Teachers' Characteristics and Instructional Practices	0.060	0.449	0.111	0.138
	School Climate	-0.117	0.826	-0.158*	0.035

Note. *significant at 0.05 level

The age of female students was found to have no significant correlation with their perception of teachers' characteristics and instructional practices, but was significantly correlated with the school climate. This result implies that as one female student's age increased, her perception of the university being conducive for learning became stronger. Findings showed that the age of male and female respondents did not significantly correlate with parents' involvement in school. This implies that age did not significantly influence how parents involve themselves in the studies of their children. This is contrary to the arguments of Jaiswal and Choudhuri (2017), saying that parents' involvement in the studies of children declines when children reach middle or above school levels.

In general, the age of male and female students did not have a significant correlation with the environmental factors predicting mathematics anxiety. This somehow contradicted a study that revealed that critical development of math

anxiety includes environmental factors like attitudes, stereotypes, and teaching styles of teachers. It was found to affect students' attitudes, motivations, and learning activities directly across all ages (Ashcraft & Ridley, 2005).

Results also showed that for females, the course was significantly correlated with their perception of parents' involvement in school. Since the correlation is positive yet weak, it is implied that a change in the course of female students could bring change in their perception of the degree of parents' involvement in their studies. This result is contradictory to a study that showed lack of relationship between course and numerical task anxiety and daily situations such as reading a cash register receipt after making purchase and four items related to a set of different mathematical problems to be solved (Núñez-Peña et al., 2013).

The year level of male students significantly correlated with their perception on parents' involvement in school, which is not true with females. This implies that when a male student stepped up in year level, his parents got less involved in his studies. This is somehow similar to the result of the study of Tella and Tella (2003), which contended that the role of parents in children's education evolves as children get older or step up in school. However, they remain as role models throughout the life of the learner.

The number of math subjects finished by both males and females did not significantly influence the involvement of parents in their studies but the number of math subjects taken by female students was significantly correlated to school climate.

Table 4

Correlation between Personal Variables and Profile, and Mathematics Anxiety

Profile	Personal Variables	Sex			
		Male		Female	
		Pearson r	Sig	Pearson r	Sig
Age	Self-efficacy	0.065	0.413	0.083	0.268
	Mathematical Background/Attitude				
	Growth Mindset	0.090	0.259	-0.040	0.591
	Relationship between Math and the Real World	0.113	0.156	-0.029	0.703
	Sense-making	0.061	0.441	0.062	0.409
	Self-esteem	-0.056	0.483	0.020	0.786
	Math Competence	-0.030	0.702	-0.026	0.733

Table 4 continued.

Profile	Personal Variables	Sex			
		Male		Female	
		Pearson r	Sig	Pearson r	Sig
Course	Self-efficacy	0.340*	<.000	0.144	0.053
	Mathematical Background/Attitude				
	Growth Mindset	0.202*	0.010	-0.077	0.307
	Relationship between Math and the Real World	0.206*	0.009	-0.025	0.737
	Sense-making	0.0063	0.399	0.063	0.399
	Self-esteem	0.129	0.104	0.144	0.053
	Math Competence	0.069	0.388	0.318*	<0.001
Year Level	Self-efficacy	0.140	0.079	0.093	0.213
	Mathematical Background/Attitude				
	Growth Mindset	-0.010	0.896	0.019	0.803
	Relationship between Math and the Real World	0.020	0.799	0.085	0.259
	Sense-making	0.108	0.149	0.108	0.149
	Self-esteem	0.002	0.979	0.007	0.921
	Math Competence	0.013	0.868	0.128	0.086
No. of Math Subjects taken	Self-efficacy	0.149	0.060	0.106	0.156
	Mathematical Background/Attitude				
	Growth Mindset	0.015	0.854	0.035	0.638
	Relationship between Math and the Real World	0.058	0.467	0.075	0.318
	Sense-making	0.050	0.507	0.050	0.507
	Self-esteem	0.046	0.565	-0.009	0.905
	Math Competence	0.030	0.709	-0.018	0.810

Note. *significant at 0.05 level

The age, year level, and a number of math subjects taken by male and female students were found to have no significant correlations with the different personal variables like self-efficacy, mathematical background, self-esteem, and math competence. Some findings agree with London (2016), who revealed significant differences in self-efficacy and gender but found no statistical difference in self-efficacy and age groups. Further, it contradicted the study of Albion et al. (2011), which showed that general self-efficacy, proactive attitude, and proactive coping scale scores were correlated and a moderating effect on age.

Results showed that the course of male students was significantly correlated to their self-efficacy, growth mindset, and belief that that math and the world are related. Meanwhile, females' course was found to have significant correlation with math competence.

Some of the results revealed similarities with the findings of Shaukat and Bashir (2016) that students' competence varied by course.

Table 5

Model Summary of Mathematics Anxiety of Male and Female Students

Model Summary				
Math Anxiety Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
Male	.864	.746	.359	.38145
Female	.835	.698	.348	.31387

The table provides the R and R^2 values. The R-value represents the multiple correlation coefficient for male and female students and is equal to is 0.864 and 0.835, respectively. The values indicate a good level of prediction and imply a high degree of correlation. The R^2 indicates how much the total variation in the dependent variable (mathematics anxiety) can be explained by the independent variables, which include profile and environmental and personal predictors of math anxiety. In this case, 74.6% and 69.8% of the variability of males' and females' mathematics anxiety can be explained by the independent variables.

Table 6

Statistical Significance between the Mathematics Anxiety of Male and Female Students and the Different Variables

ANOVA						
Math Anxiety Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Male	Regression	26.940	96	.281	1.929	.003
	Residual	9.167	63	.146		
	Total	36.107	159			
Female	Regression	18.886	96	.197	1.997	.001
	Residual	8.176	83	.099		
	Total	27.062	179			

The F – ratio in the ANOVA table tests whether the overall regression model is a good fit for the data. As shown, the independent variables statistically and significantly predict the mathematics anxiety of male and female students, F (96,63)= 1.929,p=0.003 and F (96,83)= 1.9297,p=0.001 which that the regression is a good fit of the data. Thus, the independent variables significantly predict the dependent variable.

Table 7

The Identified Discriminators of Mathematics Anxiety of Male and Female Students the Fisher Function Coefficients

Classification Function Coefficients		
Predictors	**Sex**	
	Male	**Female**
Environment Variables/Factors		
a. Parents' Involvement in Studies or at School		
6. My parents demonstrate support for my extra – curricular activities.	.373	-.328
7. My parents seem to be proud of me when I receive good grades.	2.529	3.065
8. Focusing on studies is stressed out at home.	2.365	2.691
Personal Variables/Factors		
a. Self – Efficacy		
5. Thanks to my resourcefulness, I can handle unforeseen situations.	1.899	2.334
6. I can solve most problems if I invest the necessary effort.	3.232	3.711
b. Relationships between Math and the Real World		
3. School mathematics has a lot to do with what I experience in the real world.	3.972	4.079
c. Sense – Making		
1. I am satisfied if I can do the exercises for a math topic, even if I do not understand how everything works.	4.061	3.829
2. I expect formulas to help my understanding of math ideas, they are not just for doing calculations.	2.140	2.432
3. In math, it is important for me to makes sense out of formulas and procedures before I use them.	.538	.617
10. With my knowledge in math, I know I can be successful in it.	.307	.164
d. Self – Esteem		
1. On the whole, I am satisfied with myself.	1.117	.917
8. I have respect for myself.	3.535	3.853
(Constant)	-41.576	-45.528

The discriminators for mathematics anxiety of male are year level, their belief that their parents demonstrating support for their extracurricular activities, being satisfied with doing exercises in math, they can be successful with their knowledge in math and being satisfied with their whole self. Meanwhile, discriminators for females' math anxiety are their belief that parents are proud of them getting good grades, the importance of education stressed out at home, being able to handle unforeseen situations because of their resourcefulness, investing effort is necessary in solving most math problems, school math does a lot in the real world, formulas help them understand math ideas and concepts, making sense out of formulas and procedures before utilizing them and having self – respect. These discriminators make the anxiety models for males and females unique from each other.

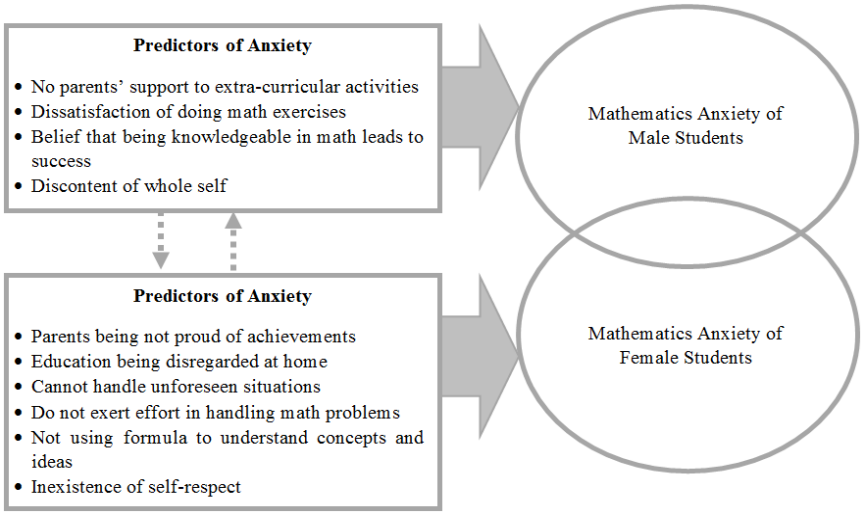

Figure 2. Differential Model of Mathematics Anxiety.

The mathematics anxiety of male and female students in a state university is influenced by various environmental and personal variables. Anxiety among males is predicted when they do not receive support from their parents about the activities they do outside of their academic endeavors. When they feel unsatisfied about doing mathematics exercises, their anxiety is influenced. Their belief that one's knowledge about math leads to success is contributory to their anxiety. When they feel discontent about their whole being, their mathematics anxiety is also affected. Further, the mathematics anxiety of female students is predicted by having parents who are not proud of the achievements of their children. When education is disregarded at home, their anxiety is influenced. When a female student cannot manage unexpected and unforeseen situations, her anxiety in math is affected. A female who does not give effort in handling problems and does not utilize formulas to understand certain math concepts and ideas leads to having anxiety. The absence of self-respect among female learners also influenced their anxiety towards mathematics.

The differential model produced was created from the analysis of data which utilized correlation coefficients, multiple regression, and discriminant analyses which identified the predictors of mathematics anxiety of the two sex groups of state university students.

CONCLUSIONS

Based on the findings, both male and female learners felt emotionally incapable of doing mathematics-related activities and could not do good in mathematics tests. Female students possessed greater fear about people's math abilities or were punished or embarrassed for not doing good in the subject and were more likely to avoid tasks related to the subject. The mathematics anxiety models of male and female students were uniquely predicted by different profile, environmental and personal variables.

RECOMMENDATIONS

From the conclusions stated above, mathematics teachers/instructors, with guidance counselors, may look into activities that can help lessen the mathematics anxiety among their students. Activities that may be looked into should address learners' emotions, assessment/test and environment anxiety, and general mathematics anxiety. Parents should continue supporting their children's studies by encouraging them to do good in the university and help them develop good study habits. Less supervision may be required, but non-supervision is discouraged. Mathematics teachers may try switching from being traditional to being constructivist in using modern-day resources, methods, and strategies in carrying out math lessons. Learners' self-efficacy or belief to do well in every new and difficult situation to balance the existence of mathematics anxiety among learners. This could be done by using contextual or real-life scenarios in mathematics problems or making connections between math and the real world. Often, students become fearful of math because they were not familiar with the things given in the mathematical problem.

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