

The Influence of Math Anxiety and Reduction Strategies to the Teacher Education Students' Scholastic Performance

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Abstract Math anxiety have always been known to have negative effects on the academic performance of students. This study determined the level of math anxiety and the anxiety reduction strategies employed by the Teacher Education students. The data were collected using questionnaires distributed to the 172 Teacher Education students chosen using a stratified random sampling procedure. The anxiety and anxiety reduction variables were correlated with the Quality Point Average (QPA) grades of the students for the whole semester. This investigation found that the students experienced a fair amount of math anxiety and sometimes employed strategies to reduce their level of anxiety. Pearson r correlation determined that math anxiety has weak negative relationship with the QPA while reduction strategies have no relationship at all. Thus, math anxiety adversely affected the scholastic performance of the students. It is recommended that teachers create a positive learning environment employing relevant real life problems so students appreciate Mathematics as a tool that can be used in life and that the guidance office may provide counseling sessions to students with high math anxiety.

Keywords: math anxiety, math anxiety reduction, quality point average, scholastic performance

Introduction

Mathematics is part of every curriculum but is also the discipline that causes anxiety at the same time. Dreger and Aiken (1957) introduced mathematics anxiety as a new term to describe students' attitudinal difficulties with mathematics, and defined it as the presence of a syndrome of emotional reactions to mathematics, but Richardson and Suinn's (1972) definition is commonly used. Accordingly, math anxiety is a tension and anxiety on manipulating numbers and solving mathematical problems. The negative feelings towards mathematics and reluctance to participate in math activities is more prevalent in middle school, providing a challenge to teachers (Calder & Campbell, 2015; Hilmi & Hamzah, 2016; Willacy & Calder, 2017). In fact, in 2012, Yahya and Fasasi claimed that fear in mathematics is an academic infection and the faces of the students in the classes show the signs of this anxiety. They have shown motivational difficulties or do not possess a positive attitude toward the subject.

Suarez, Pena and Colome (2015) said that typically, math phobias are developed when math is presented to the students in such a fashion that it has led to circumscribed understanding and makes it even more confusing. Much has been written about math anxiety, which can be described as reluctance to engage in, and trepidation of, mathematics-cognate activities. Individuals who exhibit such apprehensiveness do not relish doing arithmetic, concretely in public. They agonize over arithmetic, apologize for their lack of adeptness and evade association with mathematics. Mathematics anxiety has been found to decrease the efficiency of an individual's working memory because intrusive thoughts and worries take the focus away from the mathematics at hand. This scheme makes it difficult for individuals to think logically, increased errors and longer processing times when mentally solving problems. In the long term, mathematics anxiety leads to decreased competence,

reduced completion rates and lower academic performance in the subject (Zacaria & Nordina, 2008).

The Teacher Education students are not exempted from math anxiety regardless of their curricular year because of the challenges in learning higher level mathematics in college. In addition, they need to meet the required QPA in order to qualify to proceed to the next year level. QPA is the average grade attained by the students in a semester. This QPA requirement is a retention policy based on a Board Resolution in 2004 that enacts an “Open Admission but Strict Retention Policy”. The QPA acts as an assurance that teacher graduates have a higher chance of passing the Licensure Examination for Teachers.

This research is aimed at describing the prevailing anxiety and coping levels of the students and how these have affected their performance. It also looked into what certain situations have affected them the most. Since math anxiety researches have been focused on elementary and high school levels and these have been found to be adversely affecting their academic performance, this investigation focused on the college students specifically the Teacher Education students. Several studies have identified that teachers with math anxiety have also the tendency to contribute to their students’ math anxiety. This research investigates how, as teacher education students and as future teachers, fare in mathematics in terms of their anxiety level and the mechanisms they applied to reduce their feelings of anxiety. This current work then explores how math anxiety and the anxiety reduction strategies affect the students’ scholastic performance in terms of QPA.

Effects of Mathematics Anxiety on Scholastic Performance

Anxiety has recently been considered as a significant factor in shaping mathematics learning, mathematics performance and basic numerical abilities of adults in the classroom (Maloney & Beilock, 2012). Ng (2012) in Singapore

showed a negative correlation of math anxiety with achievement and that almost 40% of the secondary school students indicated that they are very nervous when waiting to receive their marked papers. It also showed that four of the top five situations that are most stressful to students were related to mathematics tests.

In 2013, Karjanto and Yong studied the level of math anxiety among early undergraduate students at the University of Nottingham Malaysia campus. The sample students completed test anxiety questionnaires before their midterm examinations. The level of test anxiety used a 7-point Likert scale adapted from the text Anxiety Inventory describing one's emotional feeling before the start of the examination. The result reveals that students who had a lower score expectation in the examinations were more anxious than those who had a higher expectation. However, those who have lower expectations in their test scores actually obtained higher than their expected test scores. Similarly, a study by Taylor and Fraser (2013) among the high school students from four schools in Southern California using an updated Revised Mathematics Anxiety Rating Scale found that there is a significant association between anxieties and learning environment. They defined learning environment as the "social, psychological, and pedagogical context in which learning occurs and which affect student achievement and attitudes". Arem (2009) even posited that students with high mathematics anxiety levels engage in negative thinking about their self-ability. These students will exhibit less confidence in working with numbers and mathematical concepts through a problem-solving process. For Lebens, Graff and Mayer (2011), Young children must learn the basic foundations of math subject, which is useful in functioning well in their everyday lives.

Beesdo and colleagues (2009) mentioned that anxiety disorders are the most common mental disorders in children. For instance, generalized anxiety disorder, specific phobias, and social phobia can all be observed in children (Zacaria

& Nordina, 2008). However, the age of onset of mathematics anxiety is unclear. Most recent researches suggest that mathematics anxiety is detectable as early as Grade 1 (Harari, Verkovic, & Bailey, 2013) but majority of the research claims that the generally accepted age of onset mathematics anxiety is Grade 3 (Wu, Barth, Amin, Mclarne, & Menon, 2012). Looking specifically at children, recent research presents conflicting findings regarding math anxiety and math achievement. Jameson (2013) have shown an inverse relation between math anxiety and math performance in early elementary school students but a longitudinal study of children between first and third grade by Krinzinger, Kauffman and Willmes in 2009 found no relation between math anxiety and math performance.

Much literature on math anxiety, which focused mainly on adults provide evidence of detrimental effects of math anxiety at an early age. Recent work suggests that some children report experiencing math anxiety as early as first and second grades. Paradoxically, those with higher working memory show the most profound negative relation between math anxiety and math achievement (Vukovic, Kieffer, & Harri, 2013).

Causes of Mathematics Anxiety

Most individuals with mathematics apprehensiveness are beyond elementary school age. Calder and Campbell (2015), Hilmi and Hamzah (2016) and Willacy and Calder (2017) stated that the dislike of mathematics and reluctance to participate in activities is more prevalent in middle school, providing a challenge to teachers. In 2014, Shamoan cited that anxious teachers spend lesser time teaching mathematics and are more likely to pass their phobia to their students. Geist (2015) even examined training teachers attitude towards mathematics and found that math anxiety affects how teachers assess their ability in mathematics. He also found that confident teachers are more likely to use developmentally appropriate methods of teaching mathematics. Given this observation,

Eugene suggested that in-service trainings should take place to add focus on teachers' confidence in mathematics to enhance the mathematics outcomes for children and their ability and enjoyment of mathematics. In 2010, Beilock, Gunderson, Ramirez and Levine found that as the school progressed, highly math anxious teachers were likely to endorse gender stereotype about math that female students have lower math achievement than teachers with low anxiety. It is generally accepted that teachers impact learners in many ways. Levine (2008) found that teachers with mathematics anxiety emphasize rule-based strategies and treat mathematics as an arbitrary collection of facts, perhaps to promote an illusion of their expertise and disciplinary power to students. Furthermore, there is often limited classroom interaction, resulting to students' questions not being asked or answered, and knowledge presented as limited or confusing.

Reducing Math Anxiety

In order for teachers to reduce math anxiety, they could develop strong skills and a positive attitude toward math. Jackson's (2008) survey of British primary teaching students found that 68% of respondents indicated lack of confidence in their ability to teach math and 81% reported that they experienced negative physical and/or emotional feelings about math. Beilock and colleagues (2010) found that children are more likely to emulate the attitudes of same gender teachers. Since most elementary teachers are female, the researchers concluded that girls are more likely to be affected by their teachers' negative attitude towards mathematics than boys. Teachers should also encourage active learning. Studies have found that students learn best when they are active rather than passive learners. They must be engaged in exploring, thinking, practicing and using knowledge, rather than listening to verbal description of concepts. Thus, Sun and Pyzdrowski (2009) suggested that teachers incorporate games and activities into math lessons so that students can experience math in a

hands-on fashion. Teachers should also provide support and encouragement to students by emphasizing that everyone makes mistakes, and refrain from tying self-esteem to success in math (Geist, 2008). Jackson (2008) ever noted that some students may believe when a teacher tells them they cannot do math, and it takes only one teacher to create lasting math anxiety in a student.

Similarly, students can also reduce their math anxiety by practicing math everyday (Freedman, 2010), practicing relaxation techniques, and focusing on past successes. Freedman emphasized that repetition is important in math and that with practice, students will develop the self-confidence needed to solve mathematical problems.

Purposes of the Research

The main goal of the research is to determine if math anxiety and reduction strategies influence the scholastic performance of the Teacher Education students. Specifically, this research looks into the following:

1. To what extent is the math anxiety of the Teacher Education students?
2. To what extent is the anxiety reduction strategies employed by the Teacher Education students?
3. What is the Quality Point Average (QPA) performance of the Teacher Education students, and
4. Is there a relationship between math anxiety and reduction strategies to the scholastic performance of the Teacher Education students?

The literature shows that math anxiety can adversely affect performance and these are also partly caused by teachers. Most of those being studied are students in elementary and secondary levels. Thus, this investigation would like to know if

the Teacher Education students also experienced math anxiety in order to provide avenues for the resolution of this anxiety as part of their preparation as future teachers.

Methodology

Research Design

In this study, a quantitative-descriptive survey research method was used with focus on primary and secondary data collections for the level of math anxiety, anxiety reduction strategies and scholastic performance based on the students' Quality Point Average.

Participants

There are 172 Teacher Education students who participated in the study; 76 of whom are Bachelor in Secondary Education (BSED) and 96 are Bachelor in Elementary Education (BEED). They were sourced through stratified random sample from 301 enrolled BSED (133) and BEED (168) students in Siquijor. The sample is composed of 30 male and 142 female respondents. The respondents were informed about the purpose of the study and the method to be undertaken in order to collect the data. They were assured that their names will not be mentioned in the output, instead, a code is provided to each name to maintain anonymity. To determine their respective QPAs, the code assigned to each respondent was utilized for the statistical analysis. After the students' consent was secured, they were allowed to bring the questionnaire home and were also given the information that at any point of the data collection period, they can withdraw from the study. Nobody withdrew and the study was able to retrieve all the questionnaires.

Instrument

The instrument for this study is a questionnaire developed by the researcher based on various existing literature on Math anxiety. The items that were used in the questionnaire were taken from various educational psychology books and from on-line literatures. The questionnaires were modified to ascertain the degree of the items presented and to fit the environment of the students. However, the essence of the statements was still retained despite the minor revision or modification. The questionnaire has a predetermined set of questions used to collect data. This instrument is divided into two parts. The first part focused on the attitudinal responses to situations that would reveal the students' level of math anxiety such as evaluative tests and mathematical problem solving while the second part of the questionnaire is the coping mechanisms employed by the students in order to reduce their math anxiety. The level of math anxiety and anxiety reduction utilized the 5-point Likert scale. The questionnaire was pilot-tested to other teacher education students who were not part of the research, deducing a reliability index of .846. Some items were deleted and modified after the dry run to improve its comprehension and acceptability so for the math anxiety and anxiety reduction, only 23 out of 25 items were left and 21 out of 25 were left respectively. However only 20 items were used per variable. Of the 20 items, only the first 10 highest level of anxiety and reduction strategies were presented in the discussion of results since this study only focuses on the items with highest levels of anxiety and reduction strategies.

Data Collection and Analysis

The questionnaires were administered to the respondents and they were allowed to bring them home so they can reflect on the given situations. The data were collected within a week. There was a 100% retrieval of the 172 questionnaires floated to the teacher education students.

The collected data on the level of math anxiety and anxiety reduction techniques were analyzed using the Weighted Mean while the test for relationship of variables used the Pearson r analysis.

Results and Discussion

This section presents the findings on the level of math anxiety of the teacher education students, their strategies in order to reduce their anxiety, their scholastic performance in terms of Quality Point Average and the relationship of these variables in determining whether anxiety and reduction strategies influence the students' scholastic performance.

Extent of Math Anxiety

Table 1 shows that the Teacher Education students also experience math anxiety to a fair amount when it comes to studying for the midterm and final exam in Mathematics and building new mathematical knowledge through problem solving. They experience math anxiety only to a little extent when they solve quandaries that arise in mathematics and other concepts, apply and adapt a variety of strategies to solve problems, monitor and reflect the process of mathematical quandary solving, recognize reasoning looking and using reasoning as a fundamental aspect of mathematics, make and investigate mathematical conjectures, develop and evaluate mathematical arguments and on how to understand how mathematical ideas interconnect and build one another to produce a coherent whole.

Table 1. Extent of Math Anxiety

Experiences of math anxiety	Composite mean	Interpretation
Studying for a midterm exam in Mathematics	3.34	Fair Amount
Studying for final exam in Mathematics	3.13	Fair Amount

Building new mathematical knowledge through problem solving	2.80	Fair Amount
Solving quandaries that arise in mathematics and other contexts	2.59	A Little
Applying and adapting a variety of appropriate strategies to solve problems	2.57	A Little
Monitoring and reflecting on the process of mathematical quandary solving	2.53	A Little
Recognizing reasoning and reasoning as fundamental aspects of mathematics	2.50	A Little
Making and investigate mathematical conjectures	2.47	A Little
Developing and evaluate mathematical arguments	2.47	A Little
Understanding how mathematical ideas interconnect and build one another to produce a coherent whole	2.25	A Little

Legend

Scale	Range	Description	Explanation
5	4.20-5.00	Very Much	10 out of 10 instances
4	3.40-4.19	Much	7-9 out of 10 instances
3	2.60-3.39	Fair Amount	5-6 out of 10 instances
2	1.80-2.59	A Little	1-4 out of 10 instances
1	1.00-1.79	Not at All	0 out of 10 instances

In general, the students are anxious when they are faced with something new to learn in mathematics. For them, connecting and making sense of figures require a lot of effort, which lowers their confidence in their capacity to learn new math skills and knowledge. Moreover, trying new problem solving strategies in mathematics and trying to make sense of the quandaries or vague aspects of the problem added to their discomfort and anxiety. These anxieties are also aggravated by their desire to meet the desired minimum grades and QPA such that getting high scores in the midterm exam and the final exam. Major examination comprises 40% of their term grades which makes it a crucial factor in attaining the desired grade to meet the QPA. The higher they go up the curricular year, the higher the grades and QPA requirement that they need to meet. These two factors have greatly contributed to their math anxiety.

The first year or the freshmen teacher education students experience the highest anxiety. Having to consider a different learning environment from basic to higher education, they are apprehensive about how they could perform in mathematics. Since the school curriculum have two major examinations—midterm and final, which comprise 40% of their grade, they are bothered about having to understand and correctly solve mathematics tests in order to pass. This result is similar to the finding Ng in 2012 in Singapore that the four of the top five situations that are most stressful to students were related to mathematics tests. Mathematics anxiety has been found to decrease the efficiency of an individual's working memory because intrusive thoughts and worries take the focus away from the mathematics at hand. This makes it difficult for individuals to think logically and results to increased errors and longer processing time when solving problems mentally (Zacaria & Nordina, 2008). Research also indicates that there is a strong negative relationship between math anxiety and test scores. In other words, as students' math anxiety increases, their test scores decrease (Sparks, 2011).

Math Anxiety Reduction Strategies

Most of the time, when faced with math anxiety, the Teacher Education students are practicing positive self-thoughts and are more careful and discriminating when trying to analyze the problems. The primary motivation behind this is to reduce anxiety is the realization that the first to celebrate when they pass or understand math is none other than themselves. This gesture increases their morale and confidence in doing mathematics. The next is focusing on the quandaries to clear out all the points in the problem and then going through these quandaries repeatedly to ensure that they were able to get the material out of context and understand the problem. Finally, students expeditiously read the exam, connect them with past typical errors and highlight significant equations and words to avoid misinterpretation.

Table 2. Math Anxiety Reduction Strategies

Anxiety reduction strategies	Composite mean	Interpretation
Rewards oneself for a job well done!	3.87	Most of the Time
After finishing the exam, check the answers, proofread for omissions, and check for solutions on errors.	3.74	Most of the Time
Carefully read the directions to all problems and circle significant equations and words to avoid misinterpretation.	3.73	Most of the Time
Arrive at the exam on time and avoid talking to others.	3.70	Most of the Time
Say positive self-statements to one-self and push away all distracting thoughts.	3.65	Most of the Time
Proceed comfortably through the exam, working first on the quandaries that come the most easily to the students	3.64	Most of the Time
Expediently read through the exam, not point-values, and schedule the time accordingly	3.53	Most of the Time
Reviewed and worked out lots of quandaries to get the material out of context	3.40	Most of the Time
Analyzed past pattern of typical errors to be vigilant to them on the exam	3.34	Most of the Time
On practice exam, remains clam, relaxed and positive, checking breathing often.	3.33	Most of the Time

Legend

Scale	Range	Description	Explanation
5	4.20-5.00	Very Much	10 out of 10 instances
4	3.40-4.19	Much	7-9 out of 10 instances
3	2.60-3.39	Fair Amount	5-6 out of 10 instances
2	1.80-2.59	A Little	1-4 out of 10 instances
1	1.00-1.79	Not at All	0 out of 10 instances

As gleaned from Table 2, students exhibit a higher level of anxiety reduction, which reveals their conscious effort to understand mathematics more in order to combat their anxiety. For the freshmen, they recognize that being new in college requires a lot of adjustment, not just socially and mentally but also in the learning of higher level of mathematics. When it comes to their test anxiety, they learn to minimize by reviewing their answers as against the directions and checking their

solutions. As for the respondents from the higher year levels like the 3rd and 4th year students, they still experience anxiety but they try to minimize its adverse effect by focusing on positive or affirmative attitudes and being careful to review and check their answers during tests to ensure that they get more correct answers. This way, they will be able to achieve higher test scores.

Students try to maintain a positive outlook in order to reduce their math anxiety. They recognize their efforts by rewarding themselves to improve their confidence and they do away with distracting thoughts that might interfere with their concentration and add more to their confusion. They focus on the test at hand by carefully reading the directions and reviewing their answers to ensure a higher chance of passing the math test. They arrive early in the venue to familiarize themselves with the environment and they try to avoid talking to others so they would not have to share their anxiety or add more to their anxiety. Perry 2004, as cited in Tenenbaum (2012) offered students three valuable suggestions to reduce their anxiety. First, students must direct their energies towards improving their mathematical abilities and solving problems, not as scapegoats. Next, students should not fall prey to negative racial or gender stereotypes that may lead them to believe that they cannot do well in mathematics and finally, the most important counter-anxiety technique is simply to keep a positive attitude.

QPA Performance of Teacher Education Students

The minimum Quality Point Average (QPA) required for the Teacher Education students is 80% for the first year; 83% for the second year and; 85% for both the third and fourth year levels. The QPA is taken from all the subjects enrolled for the current semester. The figure below shows the distribution of the respondents based on the required minimum QPA per category.

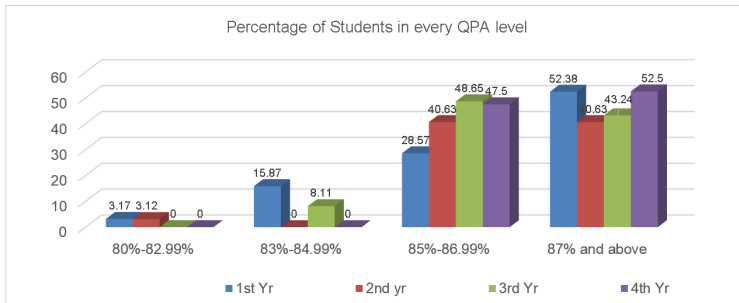


Figure 1. QPA Performance

Most of the teacher education students have met the minimum Quality Point Average as required per curricular year. Except for one 2nd year and three 3rd year students who failed to meet the QPA, all the rest of the respondents have met the required minimum QPA. This data show that the respondents have attained a higher performance compared to their minimum requirement. This further reveals that the majority of the students have attained more than 85% of their QPA which describes them as above average students.

Relationship between Math Anxiety and Anxiety Reduction Strategies to Scholastic Performance

Table 3 presents the relationship between math anxiety and scholastic performance and anxiety reduction strategies and scholastic performance. With a p= value of .151, the variables have different effects on scholastic performance of the students.

Table 3. Relationship between Math Anxiety and Anxiety Reduction Strategies to Scholastic Performance

Scholastic Performance and:	Critical Value	Computed Value
Math Anxiety	3.925	5.492
Anxiety Reduction	3.925	3.040

* $\alpha = 0.05$ level of significance

Table 3 shows that anxiety reduction did not affect scholastic performance, but discloses that math anxiety has a weak negative relationship with scholastic performance. Thus, their level of anxiety may have adversely affected their QPA performance. This means that the students' performance decreases because they are already disturbed by their anxiousness in mathematics. This finding coincides with that of Zacaria and Nordina (2008) that in the long term, mathematics anxiety leads to decreased competence, reduced completion rates and lower academic performance in the subject.

Conclusion and Recommendations

This investigation tried to determine if a relationship between math anxiety and anxiety reduction to the scholastic performance of the Teacher Education students exists. The findings could be of help in analyzing what aspects of math anxiety are being experienced more by the students and what were their various reduction strategies in order to address their anxiety. Studying the Teacher Education students' math anxiety could help them to address this challenge so they be better prepared when they are engaged in the teaching profession in the future.

It was found out that the most of the causes of the students' math anxiety is during evaluative activities such as the midterm and final examinations as well as in building new mathematical knowledge through problem solving and adapting a variety of appropriate strategies in problem solving. However, students also use affirmative self-talk to ease the anxiety and to be cautious in checking and reviewing their answers to increase their anticipation of getting higher scores in tests.

The scholastic performance of the students revealed that most of them belong to the above average category but this

can still be affected by math anxiety since it was found out that there is a weak negative relationship between math anxiety and scholastic performance. Although there is a higher degree of anxiety reduction strategies employed by the students, these do not have any bearing on their academic performance.

This study is limited to data deduced from a questionnaire and the records of the students' Quality Point Average. It is recommended that an in-depth study using qualitative methods will be conducted to further analyze other factors affecting the students' math anxiety and how effective were the anxiety reduction strategies.

For the school, since new college students need to adjust to a new learning environment and a different curriculum, the key implication is for teachers to create positive learning environment focusing on using tests as a measure of performance and not of error to lessen student's test and math anxiety. The guidance office may provide counseling sessions to students with high math anxiety. Include in the homeroom guidance activities, topic and activities that address math anxiety and promote anxiety reduction techniques or strategies. There is a need to employ relevant real-life or situational problems and applications in teaching in order to motivate students and to be aware that Mathematics is a tool subject, as such it is useful. More hands-on exercises in Mathematics be provided in the classroom as a practice and improve familiarization and understanding of the math concepts. Lastly, teachers may be sent to trainings or seminars to keep them abreast with the new trends in Mathematics teaching.

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