Mathematics Anxiety, Conception and Performance of the University Freshmen Students

Gerald S. Navida

College of Teacher Education, Pangasinan State University-Alaminos City Campus**,**
Philippines

Abstract

Mathematics anxiety and conception of students may have detrimental effects on their performance. The study assessed the level of mathematics anxiety of the university freshmen students and its relationship to their conception and performance in mathematics. The study employed the descriptive-correlational research design with 144 freshmen students as respondents. Data were gathered using survey questionnaires. Findings disclosed that freshmen students have a moderate level of math anxiety and satisfactory performance in mathematics. Most of the students believed that mathematics is not just a thought process but also a system with crucial role in day-to-day life. The study found out that math anxiety level and performance of freshmen students were not significantly related. Moreover, conceptions of students in mathematics and mathematics learning approach were determinants of their math anxiety level. The several causes of math anxiety of freshmen students suggest the need to implement appropriate teaching strategies or methods that will arouse students' interests in mathematics.

Keywords: freshmen students, math anxiety, performance, conception in mathematics, mathematics learning approach, causes of math anxiety

1. Introduction

Mathematics is still viewed by many students as one of the most challenging subjects ever taken. The result of the 2018 Programme for International Student Assessment (PISA) shows that the Philippines ranked the lowest in the areas of mathematics, science and reading. The result of the PISA calls for an urgent action to further improve the quality of education in the country especially in mathematics.

One of the primary goals of the education system today in the Philippines and abroad is strengthening mathematics education. Mathematics education in the Philippines aims to provide means of making sense of the world; serve as mode of communication and operate as a doorway to national progress (SEI-DOST & MATHTED, 2011). With the new curriculum in the country for mathematics education in the basic education (K-12 Curriculum), students are expected to be more prepared for learning mathematics in higher education. However, mathematics education in the previous curriculum has focused more on efficient computation

and not too much on the understanding of concepts, problem-solving, and application of mathematics in real-life situations.

In order to realize the needed reforms in mathematics education, mathematics educators should address some emerging problems which may hinder students to perform well in mathematics. Mathematics is often associated with failure and frustrations. Students' prior negative experiences in math classrooms may have influenced their conception in mathematics. Also, this may have caused them to have lack of interest in the subject. Their negative beliefs and attitudes towards mathematics brought about by how they conceive it can affect their performance.

When it comes to learning mathematics and performance of students, anxiety may have an adverse effect. Mathematics makes some students feel anxious, leading them to avoid situations where they may have to use mathematics (Chinn, 2012). People who feel tension, nervousness, and fear of situations concerning math might have anxiety in the subject (Yang, 2014). Students are anxious at times, which can result to poor performance in mathematics. Moreover, mathematics anxiety is related to students feeling nervous, tense, or anxious when working with numbers or solving mathematical problems (Richardson & Suinn, 1972).

Students who suffer from mathematics anxiety do not necessarily experience anxiety in other subjects. However, students with higher levels of mathematics anxiety are likely to develop negative beliefs and attitudes towards mathematics. When these math-anxious individuals reach college, they would probably avoid attending mathematics classes and would not pursue a career that requires them to deal with math-related situations.
Several research studies have shown the importance of conception, that is, the attitudes and beliefs, in the motivation and psychological/emotional conditions of students in learning mathematics (Sangcap, 2010; Sumpter, 2010; Crawford et al., 2006). Also, the students' prior learning experiences in mathematics have something to do with their conception, can influence their approaches in learning, their attitudes towards math, and their performance.

In the study conducted by Cocal (2017), it was found out that students usually have a shallow conception of mathematics without seeing its crucial role in their daily lives. Also, the majority of freshmen students who believed that mathematics should be learned using a low level or surface approach is approximately equal with the number of students considering that learning mathematics needs a high level or deep learning approaches. The conception of a student in mathematics and mathematics learning approach can influence his performance.

On the other hand, several studies regarding mathematics anxiety and achievement have revealed that there is a significant negative relationship between math anxiety and math performance (Shishigu, 2018; Khatoon, 2010; Karimi & Venkatesan, 2009; Luo et al., 2009). The result implies that higher levels of math anxiety can adversely affect students' performance in mathematics. If the level of math anxiety was at the average level, it indicates the existence of the construct in schools. Prior math performance is also the strongest predictor of math anxiety. Thus, students' previous experiences in mathematics adversely affect the present status of their achievement and math anxiety level (Shishigu, 2018). In addition, Estonanto & Dio (2019) emphasized that students who do not have a grasp of the fundamental theories in mathematics can make them feel nervous and anxious when taking tests and exams.

Furthermore, Luttenberger et. al. (2018) found out in their study that mediating variables may change the correlation between math anxiety level and performance. Results of their study disclosed that when learners would acquire intrinsic motivation, moderate levels of math anxiety would have a positive influence on students' performance.

In general, the study sought to determine the relationship of the freshmen students' math anxiety level to their conception and performance in mathematics as well as their conception of mathematics learning approach. Specifically, the study investigated the performance of the freshmen students in mathematics, particularly in the Mathematics in the Modern World subject; the level of mathematics anxiety of students; the conception of students in mathematics and mathematics learning approach; the relationship between the level of math anxiety and performance of students in mathematics; the relationship between the level of math anxiety and conception of students in mathematics and mathematics learning approach; and the causes of mathematics anxiety of freshmen students.

Conception of students in mathematics may have detrimental effects on students' mathematics anxiety level, which in turn can negatively influence their performance in mathematics. There are already existing studies with regards to the factors affecting the mathematics anxiety level of students. However, no study has been conducted yet with regards to the relationship between the mathematics anxiety level and conception of students in mathematics and mathematics learning approach. The results of this study would give mathematics educators insights with regards to students' level of mathematics anxiety and their conception in mathematics. Along this premise, mathematics educators can search for effective interventions to change the negative beliefs and attitudes of students towards mathematics, which in turn can reduce their math anxiety level. Having adequate knowledge about these factors would be beneficial in alleviating students' performance in mathematics.

2. Materials and Methods

2.1 Research Design

The study is a quantitative type of research, employing the descriptive-correlational research design. This design was used since the primary objective of this study was to determine the relationship of students' math anxiety level to their conception in mathematics, mathematics learning approach, and their performance in mathematics.

2.2 Respondents of the Study and Sampling

A total of 144 freshmen students in the different programs of Pangasinan State University-Alaminos City Campus (PSU-AAC), namely: Bachelor of Secondary Education major in Mathematics, Bachelor of Secondary Education major in English, Bachelor of Science in Information Technology, and Bachelor of Science in Business Administration served as respondents of the study. These freshmen students were enrolled in the Mathematics in the Modern World subject during the first semester, S.Y. 2019-2020. The respondents were randomly selected using stratified random sampling technique.

2.3 Data Collection

To obtain pertinent data for the study, the researcher distributed survey questionnaires for the target respondents to determine students' math anxiety level, their conception in mathematics and mathematics learning approach, and causes of students' math anxiety. Abbreviated Mathematics Anxiety Rating Scale (A-MARS) questionnaire was adapted to measure the math anxiety level of students. A-MARS is a 25-item standardized instrument that measures math anxiety levels, which was developed by Alexander & Martray (2018). To acquire data for the students' performance in mathematics (Mathematics in the Modern World), the researcher requested the grades of the students from the office of the registrar, with the permission and approval of the Campus Executive Director.

2.4 Data Analysis

The researcher applied statistical tools appropriate for the purpose and variables of the study to arrive at sound judgment and reliable analysis of data. Descriptive statistics were used, particularly mean, standard deviation, skewness, and kurtosis, to describe and interpret the performance of the students in Mathematics in the Modern World subject.

To determine the math anxiety level of students, the researcher utilized average weighted mean. Moreover, frequency and percentage were used to determine the conception of students in mathematics and mathematics learning approach and the causes of their math anxiety.

To establish the relationship between students' math anxiety level and their performance in mathematics, Pearson's correlation coefficient was used. Lastly, to determine the relationship of students' math anxiety level to their conception in mathematics and mathematics learning approach, eta correlation coefficient and eta-squared (eta^2) were applied.

3. Results

3.1 Performance of the University Freshmen Students in Mathematics

Table 1 shows the overall performance of the freshmen in Mathematics in the Modern World subject.

Table 1. Performance of the University Freshmen Students in Mathematics in the Modern World Subject

Statistic	Value
Mean	2.28
Variance	0.106
Standard Deviation	0.33
Skewness	0.081
Kurtosis	0.197
Minimum	1.50
Maximum	3.00

Note: The Pangasinan State University follows a grading system with 1.00 as excellent and 5.00 as failed.

The mean grade of the students is 2.28, which is equivalent to satisfactory performance. The standard deviation 0.33 implies that the freshmen students form a homogeneous group, which means that students have almost the same level of performance. The standard deviation also entails that most of the students' grades lie between 2.00 and 2.50. The skewness 0.081 implies that a more significant number of students have grades higher than 2.28 (Table 1). The skewness and kurtosis indicate that the distribution of students' grades in Mathematics in the Modern World subject is approximately normal. Findings show that there is still room for improvement with regards to the performance of the university freshmen students in mathematics.

3.2 Level of Mathematics Anxiety of the University Freshmen Students

It is disclosed in Table 2 below the level of mathematics anxiety of the freshmen students of PSU-ACC which consists of twenty five indicators.

Table 2. Level of Mathematics Anxiety of the University Freshmen Students

Indicators	AWM	Description
1. Studying for a math test.	3.31	MA
2. Taking math section of the college entrance exam.	3.33	MA
3. Taking an exam (quiz) in a math course.	3.44	MA
4. Taking an exam (final) in a math course.	3.55	HA
5. Picking up math textbook to begin working on a homework assignment.	2.99	MA
6. Being given homework assignments of many difficult problems that are due the next class meeting.	3.30	MA
7. Thinking about an upcoming math test 1 week before.	3.22	MA
8. Thinking about an upcoming math test 1 day before.	3.33	MA
9. Thinking about an upcoming math test 1 hour before.	3.46	MA
10. Realizing you have to take a certain number of math classes to fulfill requirements.	3.53	HA
11. Picking up math textbook to begin a difficult reading assignment.	3.01	MA
12. Receiving your final math grade in the portal/classcard.	3.78	HA
13. Opening a math or stat book and seeing a page full of problems.	3.29	MA
14. Getting ready to study for a math test.	3.13	MA
15. Being given a "pop" quiz in a math class.	3.33	MA
16. Reading a cash register receipt after your purchase.	3.06	MA
17. Being given a set of numerical problems involving addition to solve on paper.	3.26	MA
18. Being given a set of subtraction problems to solve.	3.13	MA
19. Being given a set of multiplication problems to solve.	3.18	MA
20. Being given a set of division problems to solve.	3.19	MA

21. Buying a math textbook.	2.84	MA
22. Watching a teacher work on an algebraic equation on the board.	3.38	MA
23. Signing up/enrolling for a math subject.	3.13	MA
24. Listening to another student explain a math formula or problem.	3.42	MA
25. Walking into a math class.	3.03	MA
Overall Mean	**3.27**	**MA**

Legend: 4.51 – 5.00 - Very High Anxiety (VHA); 3.51 – 4.50 - High Anxiety (HA); 2.51 – 3.50 - Moderate Anxiety (MA); 1.51 – 2.50 - Less Anxiety (LA); 1.00 – 1.50 - No Anxiety (NA)

It can be gleaned from Table 2 that in general, students have moderate mathematics anxiety level, as signified by the average weighted mean value of 3.27. However, 15.3-32.6% of the students have high level of mathematics anxiety and 3.5-30.6% of the students have very high level of mathematics anxiety. In particular, students have high level of math anxiety in some of the indicators, namely: 'taking final exam in a math course', 'realizing you have to take a certain number of math classes to fulfill requirements', and 'receiving your final math grade in the portal/class card'. Further, the freshmen students were most anxious at receiving their final math grade, whereas they are least anxious at picking up math textbook to begin a difficult reading assignment. Results assert that there's still a need to initiate courses of action to address freshmen students' mathematics anxiety.

3.3 Conception of the University Freshmen Students in Mathematics

Table 3 presents the conception of the freshmen students in mathematics.

Table 3. The Conception of the University Freshmen Students in Mathematics

Category	Frequency	Percentage
1. Mathematics is about numbers, equations, and formula.	4	2.8
2. Mathematics is about numbers, equations, formula, and problem-solving.	34	23.6
3. Mathematics is a complex, logical, yet systematic system.	18	12.5
4. Mathematics is a complex, logical, yet systematic system used to solve complex but real-life problems.	33	22.9
5. Mathematics is life (an approach to life, a way of thinking, a technique in problem-solving, a way of understanding abstract ideas, and a tool for development).	55	38.19

Note: Multiple responses are allowed.

It can be gleaned from the table that only 4 or 2.8% of the freshman students believe that mathematics is about numbers, equations, and formula. On the other hand, 34 or 23.6% conceived that mathematics is about numbers, equations, formula, and problem-solving. Also, 18 or 12.5% believed that mathematics is a complex, logical yet systematic system while 33 or 22.9% thought that mathematics is a complex, logical yet systematic system used to solve complex but real-life problems. Moreover, 55 or 38.19% of the freshman students conceived that mathematics is life (an approach to life, a way of thinking, a technique in problem-solving, a way of understanding abstract ideas and a tool for development).

Results show that most of the students conceived that mathematics is not just a thought process but rather a system with significance and application in day-to-day life. Freshmen students believe that mathematics has a crucial role in everyone's existence.

3.4 Conception of the University Freshmen Students in Mathematics Learning Approach

It is disclosed in Table 4 the conception of the freshmen students in mathematics learning approach.

It can be noted that only 10 or 6.94% of the students consider that mathematics is about learning by memorization to reproduce or be familiarized with the knowledge and procedures. Also, 36 or 25% of the students believe that mathematics is about learning by solving lots of examples to reproduce or be familiarized with knowledge and procedures. Moreover, 34 or 23.61% of the students believe that mathematics is about learning by doing difficult problems with the intention of gaining a relational understanding of the entire theory, and seeing its relationship with existing knowledge and learning with the intention of gaining a relational understanding of the theory and looking for situations where the theory will apply.

Table 4. The Conception of the University Freshmen Students in Mathematics Learning Approach

Category	Frequency	Percentage
1. Learning by memorization with the intention to reproduce or be familiarized with the knowledge and procedures.	10	6.94
2. Learning by solving lots of examples with the intention to reproduce or be familiarized with the knowledge and procedures.	36	25.0
3. Learning by solving lots of examples with the intention of gaining understanding of the theory or concepts.	29	20.13
4. Learning by doing difficult problems with the intention of gaining a relational understanding of the entire theory, and seeing its relationship with existing knowledge.	34	23.61
5. Learning with the intention of gaining a relational understanding of the theory and looking for situations where the theory will apply.	34	23.61

Note: Multiple responses are allowed.

Further, it can be deduced from Table 4 that approaches 1 and 2 are low level approaches in learning mathematics while approaches 3, 4, and 5 are in the higher level of cognitive process, and are considered more difficult approaches in learning mathematics. Results disclosed that 67.35% of the freshmen conceived that mathematics requires a higher level or more difficult approaches in learning. In contrast, the remaining 35.65% believed that mathematics could be learned using a low level or surface knowledge. Hence, a more significant number of students believed that mathematics could be learned using higher level or deep approaches.

3.5 Relationship of Math Anxiety Level of Students to their Performance, Conception in Mathematics and Mathematics Learning Approach

Table 5 presents the relationship between the freshmen students' math anxiety level and performance in mathematics.

Table 5. Relationship of Math Anxiety Level of Students to their Performance, Conception in Mathematics and Mathematics Learning Approach

Associated Variables	Pearson's r	Sig.	Remarks
Math Anxiety Level and Performance	-0.057	0.50	Not Significant
	eta	eta^2	
Math Anxiety Level and Conception in Mathematics	0.641	0.4109	Strong
Math Anxiety Level and Conception in Mathematics Learning Approach	0.668	0.4462	Strong

*significant at $p < 0.05$

It can be observed from Table 5 that level of math anxiety of students is not significantly related to their performance in mathematics as signified by the significance value of 0.50 which is greater than the set 0.05 level of significance. The table shows that the correlation coefficient -0.057 is negligible since it is too close to zero. Thus, university freshmen's math anxiety level did not significantly influence their performance in mathematics.

It is also disclosed in Table 5 the association or relationship of students' math anxiety level to their conception in mathematics and mathematics learning approach. Findings show that there is a strong relationship between students' math anxiety level and conception in mathematics. Furthermore, 41.09% of the variance in their math anxiety level is explained by their conception in mathematics. Moreover, it can also be noted that there is a strong relationship between math anxiety level and their conception in mathematics learning approach. Specifically, 44.62% of the variance in their math anxiety level is accounted for their conception in mathematics learning approach. Thus, the way students conceive

mathematics and mathematics learning approach can be factors that affect their level of math anxiety.

3.6 Causes of Mathematics Anxiety of the University Freshmen

Table 6 shows the causes of the mathematics anxiety of freshmen students. For the university freshmen students, mathematics anxiety developed due to several situations related to the psycho-socio learning environment.

Table 6. Causes of Mathematics Anxiety of the University Freshmen.

Causes of Mathematics Anxiety	Frequency	Percentage
1. Nature of the subject (level of difficulty of the subject)	84	60.4
2. The impending feeling that you will fail on tests or exams	93	66.9
3. The pressure caused by time limits on tests or exams	97	69.8
4. The fear of public embarrassment	52	37.4
5. Influence of teachers	27	19.4

Note: Multiple responses are allowed.

It can be deduced from Table 6 that 69.8% or majority of the students answered that the pressure caused by time limits on tests or exams triggered their math anxiety. On the other hand, 66.9% believed that the impending feeling that they will fail on quizzes or exams caused their math anxiety. Furthermore, 60.4% thought that the nature of the subject (level of difficulty of the subject) caused them to be math-anxious. The fear of public embarrassment (37.4%) was also a reason why freshmen students have acquired mathematics anxiety. Lastly, 19.4% of the students considered the influence of teachers as a cause of suffering from math anxiety.

Findings affirm that majority of the students had developed mathematics anxiety due to the pressure and impending feeling when they take tests and exams and the nature of the subject. These results are consistent with the findings in Table 2, which revealed that students have a high level of math anxiety when taking an exam and in receiving their final grade in math. The intricate, complex, drawn-out and time-pressured tests and exams usually require intensive analysis, critical analysis, logical reasoning, and mastery of mathematical concepts and theories.

4. Discussions

The freshmen students of PSU-ACC generally have a satisfactory performance in Mathematics in the Modern World subject. Further, they have a moderate level of mathematics anxiety. Luttenberger et. al. (2018) stressed that when learners would acquire intrinsic motivation, moderate levels of math anxiety would have a positive influence on students' performance. Thus, the freshmen students' satisfactory performance in mathematics may be attributed to their intrinsic motivation in learning which could have affected their mathematics anxiety which is in the moderate level.

The satisfactory performance in mathematics and moderate level of mathematics anxiety of the students may be also attributed to their conception that mathematics is not just a thought process but a system with relevance and application in day-to-day life. This result contradicts the study conducted by Cocal (2017), which concluded that students had seen mathematics only as a process, without seeing its essential role in their daily lives. This implies that the freshmen students in general have positive conception in mathematics, which is essential in order for them not to view mathematics as an abstract subject that has no practical applications.

Moreover, a greater number of students believe that mathematics can be learned using a higher level or deep approaches than those who consider that math can be learned using shallow and surface-level approaches. This result contradicts the findings of Cocal (2017), which revealed that the number of students believing that mathematics should be learned using a low level or surface approach is equal to the number of students considering that learning mathematics requires high level or deep approaches. Findings assert that the freshmen students still view mathematics as a difficult subject which requires higher-order thinking skills. This is usually the case since math topics especially in the higher math subjects require intensive analysis.

Furthermore, mathematics anxiety level of the freshmen students and their performance in mathematics are not significantly related. This result contradicts several studies regarding the relationship between mathematics anxiety and performance, which revealed that there is a significant negative relationship between math anxiety level and math performance (Shishigu, 2018; Khatoon, 2010; Karimi & Venkatesan, 2009; Luo et al., 2009). This unexpected and interesting result is probably because of the moderate level of anxiety that the freshmen students exude in mathematics. The level of math anxiety that the freshmen students manifest is not extremely high or low, and so there is no exact and definite descriptions on how anxious the freshmen students are when dealing with mathematics in general. This implies that the moderate level of mathematics anxiety of the freshmen students does not necessarily affect their performance in mathematics.

On the other hand, there is a strong relationship between students' math anxiety level and conception in mathematics. Likewise, there is a strong relationship between math anxiety level and their conception in mathematics learning approach. Conception of students in mathematics is essential in their motivation and psychological/emotional conditions in learning mathematics (Sangcap, 2010; Sumpter, 2010; Crawford et al., 2006). Thus, the way students conceive mathematics and mathematics learning approach may influence their level of math anxiety.

It has to be noted that majority of the freshmen students have suffered math anxiety because of the pressure when taking exams and the impending feeling that they will fail. Estonanto & Dio (2019) emphasized that students who do not have a grasp of the fundamental theories in mathematics can make them feel nervous and anxious when taking tests and exams. It is therefore imperative to ensure that students have understood the concepts in mathematics and not just focus on efficient computations. Also, students' fear of public embarrassment has triggered their mathematics anxiety. This might be because of the prior negative experiences of students in the classroom. In addition, influence of teachers is

one of the sources of students' mathematics anxiety. This might be because of the factors such as the teaching strategies and pedagogical practices as well as the personality and attitude of the math teacher inside the classroom. Findings entail that mathematics educators should be encouraged to search for effective teaching strategies that will arouse and stimulate students' interests in mathematics.

5. Conclusion and Implications

The university freshmen students in general have a positive conception in mathematics as they believe that it has a crucial role in day-to-day life. They still view mathematics as a difficult subject since it requires higher level or deep approaches of learning. Moreover, the moderate level of math anxiety of the freshmen students does not necessarily affect their performance in mathematics. However, the way students conceive mathematics and mathematics learning approach may influence their level of math anxiety.

Mathematics anxiety and negative conceptions of students towards mathematics are serious problems in mathematics education that need to be addressed. The results of this study serve as a guide to other schools and universities in the country and other parts of the world especially in the ASEAN region. Implementing effective measures to address the negative conception of students in mathematics and mathematics learning approach such as utilizing appropriate instructional materials, remedial instruction and employing positive teaching approach should be a priority of mathematics educators. These interventions help reduce or even eradicate students' mathematics anxiety, which in turn could positively affect their mathematics performance.

6. Limitations

This study has been limited only to the freshmen students as respondents since they were the new entrants in the university. Other researchers might want to also include those in the higher year levels who are also enrolled in math subjects to have more comprehensive insights concerning the mathematics anxiety, conception and performance of university students.

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