

ASSESSMENT OF UNIVERSITY UNDERGRADUATE STUDENTS' MATHEMATICS ANXIETY AND CONCEPTION OF MATHEMATICS

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Abstract

Conception of mathematics held by students and their dispositions towards the subject are critical factors to be considered when ruminating on how to improve students' performance in mathematics. This study investigated students' anxiety and conception of mathematics. It also examined the influence of programme of study and gender on each of the two construct. A descriptive survey research design was used for the study. The population for the study consisted of pre-service teachers from a university of education in the southwest region of Nigeria. A total of 160 second year (200L) students made up of 87 male and 73 female students were selected using stratified random sampling. Two questionnaires, 24-items revised Mathematics Anxiety Rating Scale (MARS) with reliability coefficient of 0.90 and 18-items Conceptions of Mathematics Questionnaire (CMQ) with reliability coefficient ranging from 0.79- 0.85 (fragmented) and 0.84 -0.88 (cohesive). Results indicated that mathematics anxiety exhibited by male students [$M = 58.89$, $S.D = 14.020$] is slightly higher than that exhibited by female students [$M = 46.33$, $S.D = 10.537$]. In addition, one way analysis of variance (ANOVA) showed a statistically significant difference in the mathematics anxiety of respondents based on program of study. $F(160, 6) = 2.55$, $P < 0.05$ and the paired samples t-test computed revealed that the means representing cohesive conceptions were not significantly different from those of Fragmented conceptions [$t(160) = 0.419$, $p < .05$, *ns*]. It is recommended that deliberate effort should be made to encourage students and give proper counselling to them on how to develop positive attitude towards mathematics particularly at the foundation level.

Keywords: Anxiety, Conception, Cohesive, Fragmented

Introduction

Various factors have been adduced for poor performance of students in mathematics at all levels particularly at primary and secondary levels. Findings have shown that individual student's characteristics variables such as self- esteem, anxiety and students' concept of mathematics are important factors influencing academic achievement of students (Tella, 2007).

Mathematics anxiety as a construct has received considerable attention among researchers and mathematics educators in recent years. Nolting (2007) defined anxiety to mean stress, tension and strain brought into one's body and mind which involves the loss of

control of the body, having sweaty palms, pain in the neck which involves loss of concentration, having negative self- talk, feeling of doubt or mind wanders from test accompanied by feelings of helplessness because the anxious person feels blocked, unable to find a solution to his problem. Anxiety causes an individual to borrow from future problems and therefore, suffers the present fear. Tobias (1993) defines Mathematics anxiety as feelings of tension and anxiety that interfere with the manipulation of numbers and the ordinary life and academic situations and can cause one to forget and loose one's self –confidence. Many scholars have observed that the feeling of tension and anxiety interfere with manipulation and solving the mathematical problems in a wide variety of ordinary life and academic situations. (Suinn, 2001).

Mathematics anxiety is one of the major problems University undergraduate face when it comes to solving mathematics problems. A lot of concerns have been raised by mathematics educators and psychologist with regards to mathematics anxiety. A student who has a great ability to solve mathematics problems might not be able to do so if such student suffers from mathematics anxiety. Many like to call Mathematics anxiety a “learned anxiety” (Ashcraft and Krause, 2007). Stuart, (2000) further explained that this could be why students do not pursue advance courses in mathematics of sciences. However, the type of feelings students undergo when they are having mathematics anxiety often leads to panic and panic leads to helplessness, helplessness leads to fear, fear leads to distress, distress leads to shame, shame leads to inability to cope, then sweaty palms, nervous stomach, thinking difficulty, loss of ability to concentrate, and thus diminished their willingness to enrol and be successful in Mathematics courses (Stubblefield 2006).

Furthermore, it is more critical if the person undergoing or experiencing mathematics anxiety is the teacher, it becomes worst because, teachers who have this anxiety are likely to pass it on to, especially, vulnerable students (Wood, 1988). The participants who reported having mathematics anxiety attributed it to negative elementary or secondary interactions with teachers about mathematics, poor teaching practices while they were in school, and/or negative experiences taking algebra or geometry in high school. (McAnallen, 2010).

Students who end up having mathematics anxiety are students who have not in any way prepared for their mathematics test or examination (Stuart, 2000) i.e. when they're unable to solve mathematics questions they will be building up fear for mathematics. In other words, from personal experience, the only way to overcome mathematics anxiety is to keep

solving mathematics questions or problems daily. Stuart further pointed out that the problem of Mathematics anxiety is solved once a student on his or her own is able to provide answers to mathematics problems.

Considering the importance of pre-service teachers as future educational leaders that any action taken to solve their mathematics anxiety problem is definitely worthwhile. Mathematics anxiety is prevalent among teachers, elementary and high school students and college students. It has been argued that many elementary school teachers start their studies at the college with a lot of apprehension of and anxiety towards mathematics (Harper & Danne 1998).

In a study that sought to address issues resulting or leading to mathematics anxiety among pre-service teachers, it was reported that negative school experience, lack of family support, and general test anxiety were the main causes of mathematics anxiety (Trujillo & Hadfield, 1999). The teachers however, expressed confidence and optimism that they would overcome their anxiety over time to become effective mathematics teachers.

Many students who suffer from mathematics anxiety have little confidence in their ability to do mathematics and tend to take the minimum numbers of required mathematics courses, which has greatly limited their career choice options (Garry, 2005). Furthermore, Garry pointed out that mathematics anxiety is the outcome of low self-esteem and the fear of failure which causes problems for processing the incoming information as well as the previously learned information for problem solving (Daane & Tina, 1986). Such students according to Dane & Tina tend to avoid mathematics whenever or wherever possible. According to Ashcraft & Kirk (2001), the correlation between mathematics anxiety and academic performance is negatively significant. Moreover Clute (1994) and Hembree (1990), have found that students who have a high level of mathematics anxiety have lower levels of mathematics achievement. They have also noted that math's anxiety seriously constrains performance in mathematical tasks and reduction in anxiety is consistently associated with improvement in achievement. El-Anzi (2005) reported a negative association between academic achievement, anxiety and pessimism. Lower academic achievement was related to higher levels of anxiety and pessimism while Creed, Patton and Bartrum (2002) reported high optimism to be associated with higher levels of exploration, career planning, decision making confidence and career related goals and vice-versa, that is, high pessimism was associated

with career indecision, low achievement, low self esteem and increased psychological distress

Conceptions of mathematics

A concept is an abstraction or generalization from experience or the result of a transformation of existing concepts (Earl, 2006). Conception of mathematics deals with the way students conceive mathematics when it is explained to them.

Mathematics by its nature involves both cognition and affect and the glories of mathematics lies in the fact that mathematics does not come easily to anyone (Sutton 1997), it is in the struggle to understand and the manner in which this is met that one gets equipped in the knowledge of mathematics. However, most students often dislike mathematics as a subject. Akinsola, Tella and Tella (2007) observed that many students refer to mathematics as being difficult and as a result, it is often associated with pain and frustration which may account for the reason why they procrastinate in studying mathematics. (Hopkins, 2005; Phillips, 2000)

Despite the efforts of mathematics educators not much could be said to have been achieved going by report of student's performance at the West African Examination Council and National Examination Council examination (WAEC and NECO). Uyi Uwadiae in 2011 reported that only 38.93% of the candidates that sat for WAEC mathematics obtained credit and above. This is therefore pointing to the fact that considerable effort still has to be put into improving the state of teaching and learning of mathematics. Conception of mathematics held by students is a very critical factor which ought to be considered in any attempt made at improving understanding of and performance in the subject. Crawford, Gordon, Nicholas and Prosser (1994) reported that student's conception of mathematics affects both the quality of cognitive activity value of learning outcomes. Student's reports of their conceptions could either focus on the quantitative increase in the amount of knowledge they have or a changed understanding of the reality. Considerable research efforts have been made towards understanding student's conception of mathematics in other parts of the world, for instance, Alkhateb (2001) in the United States of America, Crawford, et al (1998) in Australia and Mji (2003) in South Africa. Relatively not much seem to have been done in Nigeria.

Crawford, et al. (1994) categorized student's conception of mathematics into two, fragmented and cohesive. In fragmented conceptions the subject was seen to be about numbers, rules and formulae while in cohesive conceptions It was seen as a complex, logical

system that helped in providing insights for understanding the World. Crawford, et al (1994, 1998) has shown that students with fragmented conceptions tend to follow a surface approach to studying mathematics. With this approach students attention and activity are centred on mere reproduction of knowledge.

Students with cohesive conceptions follow deep approach, in which a more global and personal perspective is adopted in constructing knowledge. There is the opinion that students in science are better in mathematics than non science students. This opinion is enough to poison the mind of a student who has the ability to do well in mathematics. However, when such a student starts attending mathematics classes, the fear that has been planted in his or her mind would not allow the student to conceive mathematics appropriately. There are too many cases in which research evidence does not support common opinions (Mcknight, Mayid Murphy, & Mcknight, 2000). This was the major reason this research study was undertaken, so as to provide researched evidence for opinions and comments in this respect.

Therefore it is necessary to investigate the anxiety and conception of students in mathematics. The teaching and learning of mathematics in Nigeria has been an issue of considerable research especially within the mathematics education community. Conception, belief, comprehension of mathematics held by students is a very critical factor which ought to be considered.

A lot of issues and concerns have been raised by mathematics educators and psychologist with regards to mathematics anxiety. Mathematics anxiety is one of the factors that is needed to be investigated and when we consider the usefulness of pre-service teachers as the educational leaders of tomorrow then any effort made in solving mathematics anxiety is definitely worthwhile. And also it is necessary to investigate the type of conceptions pre-service teachers have towards mathematics considering them as the education leaders of tomorrow.

Statement of Problem:

Effective learning of mathematics can be challenging and has a lot to do with a person's state of mind and his views about the subject. Mathematics disabilities, like other learning dis-orders have the power to keep students from performing up to their potential in school and beyond. Mathematics anxiety has both psychological and physical features whose effects can be counterproductive. It is a debilitating emotional reaction to mathematics which

ranges from feelings of mild tension to a strong irrational and intense fear of mathematics, overwhelming self consciousness heightened by a sense of being watched and judged by others and a fear of embarrassment which results to being unnecessarily quiet in class and inability to contribute in the discussions during mathematics lessons. Mathematics anxiety made those affected by it to develop a severe avoidance of situations involving any kind of mathematics, for example, they may not choose careers involving the application of mathematics and tend to fear any task or test that relate to mathematics. This anxiety if not curbed or treated can negatively impact the quality of life such a student will live as it can result in to anxiety disorder evidenced by uneasiness, cold or sweaty hands or feet, shortness of breath, heart palpitation, numbness, muscle tension and the likes. A student in such condition cannot learn effectively. Mathematics anxiety is associated with poor performance in school.

In addition, the discipline of mathematics presents many challenges to different learners. A lack of sufficient mathematical skill and understanding affects students' ability to make critically important educational life career decisions. Students who lack the understanding of mathematical concept will rely too heavily on rote memorization and will have difficulty in recognizing and retaining mathematics concept and generalizations. Students' views about mathematics are also important and relates to their achievement. Students who continue to suffer from mathematics anxiety may develop low self-esteem and social problems related to their lack of academic achievement. Later in life they may be more likely to drop out of school and find themselves shut out of jobs or occupations that require the ability to perform basic mathematical calculations. In view of these problems, it is necessary to investigate the anxiety and conception of students in mathematics. Conception, belief, comprehension of mathematics held by students is a very critical factor which ought to be considered.

Research Hypotheses

The following hypotheses are postulated to guide the study

- i. There is no significant difference in the mathematics anxiety of undergraduates based on program of study
- ii. There is no significant difference in undergraduates conception of mathematics based on program of study

- iii. There is no significant difference in the mathematics anxiety of male and female students
- iv. There is no significant gender difference in student's conception of mathematics

Methodology

A descriptive survey research design was used for the study. The population for the study consisted pre-service teachers from a university of education in the southwest region of Nigeria. One college (College of Science and Information Technology, COSIT) out of four colleges in the University was selected purposely because it is only the students of this College that offered mathematics as one of the required courses. Stratified random sampling was adopted using students' department as the stratum to ensure all the departments in the College are represented. A total of 160 second year (200L) students made up of 87 male and 73 female students were used for the purpose of this research because their experience in the mathematics courses are still current and are stable. Proportionate random sampling technique was used to select 10 students from Agric, 10 from Biology, 37 from Chemistry, 31 from Computer science, 41 from Human kinetics and Health education, 16 from Mathematics and 6 from Physics. Nine of the students didn't indicate their program of study.

Two instruments were used for the study. The first was the revised Mathematics Anxiety Rating Scale (MARS) by Plate and Parker, (1982). It consisted of 24 items measuring mathematics anxiety and the second was on conception of mathematics developed by (Crawford, et, al 1998) consisted of 18 items. Each item was rated on a five-point Likert type scale anchored by 1 = No anxiety and 5 = High anxiety. Cronbach alpha was computed to ascertain the reliability of scores obtained in this context. The MARS yielded an internal consistency (coefficient alpha) reliability of 0.90 while the Cronbach alpha for Conception of Mathematics questionnaire internal consistency with alpha coefficient ranging from 0.79 to 0.85 (fragmented) and 0.84 to 0.88 (cohesive) which were considered acceptable. The questionnaire was administered to the students during their lecture periods and the students were told that the information given will be used mainly for research purpose as there was no right or wrong answers.

The mathematics anxiety score was calculated from 24 items, the minimum score being 24 and maximum 96. A score of 48 and below indicates low anxiety while higher score indicates high anxiety.

A one way ANOVA was used to determine whether there is significant difference in the mathematics anxiety and conception of respondents based on their program of study.

T-test statistics was used to determine whether there is any significant difference in the mathematics anxiety of male and female students and also to determine whether there is significant difference in the conception of mathematics of male and female students.

Results

Hypothesis 1: There is no significant difference in the mathematics anxiety of undergraduates students based on programme of study

Table 1: Anxiety Status of the Respondents

anxiety status	freq	percentage
48 and below(low)	44	27.5
High above 48 (high)	116	72.5

In the present study it was found that 44 respondents (representing 27.5%) had a score of 48 and below while 116 (representing 72.5%) had a score higher than 48. Therefore majority (almost all) of the respondents had a very high mathematics anxiety.

Table 2: Analysis of Variance for Mathematics Anxiety based on Programme of study

	Sum of Squares	<i>df</i>	Mean Square	F	Sig
Between Groups	2836.429	6	472.738	2.588	.020
Within Groups	27949.946	153	182.679		
Total	30786.375	159			

To establish whether there is significant difference in undergraduates students mathematics anxiety based on programme of study, one way analysis of variance (ANOVA) was computed. Table 2 shows that there was indeed statistically significant difference in the mathematics anxiety of respondents based on programme of study. $F(160, 6) = 2.588$, $P < 0.05$. Post HOC test computed revealed that the difference existed between biology and chemistry respondents and chemistry, human kinetics and health education respondents.

Hypothesis 2: There is no significant difference in student’s conception of mathematics based on programme of study

To determine whether significant difference existed between fragmented and cohesive conceptions of mathematics among the respondents, mean scores for each of the two subscales were calculated. Result of the paired samples t-test computed revealed that the means representing Cohesive conceptions were not significantly different from those of Fragmented conceptions [$t(160) = 0.419$, $p < .05$, ns]. This result was interpreted as indicating that subjects in this study rated cohesive and fragmented conceptions, almost equally. To establish whether there is significant difference of undergraduate students conception of mathematics based on programme of study, one way analysis variance (ANOVA) was computed.

Table 3: Analysis of Variance for Conception of Mathematics based on Programme of study

	Sum of Squares	<i>df</i>	Mean Square	F	Sig
Between Groups	6852.548	6	1142.091	21.560	.000
Within Groups	8104.827	153	52.973		
Total	14957.375	159			

Table 3 shows that there is statistically significant difference in the respondent's conception of mathematics based on programme of study $F(150, 6) = 21.56$, $P < 0.05$. Post HOC test reveal that the difference occurred between Agric and Mathematics, Agric and Human Kinetics and Health Education, Agric and Chemistry, Agric and computer science, Biology and chemistry, Biology and computer science, Biology and Human kinetics and Health Education, Biology and Mathematics, Chemistry and Human kinetics and Health Education, Computer science and Physics, Computer Science and Human Kinetics and Health Education, Physics and Computer Science, Physics and Mathematics.

Hypothesis 3 There is no significant difference in the mathematics anxiety of male and female students

To deduce whether there is significant difference in the mathematics anxiety of male and female students. t – Test was computed. It was found that mathematics anxiety is not affected by respondents' gender at $p < 0.05$, however male students exhibited slightly higher mathematics anxiety than [$M = 58.89$, $S.D = 14.020$] female students [$M = 46.33$, $S.D = 10.537$].

Hypothesis 4 There is no significant gender difference in student’s conception of mathematics

Table 4 Percentage distribution of respondents by conceptions

Conception	Male	Female	Total
Fragmented	58.1% (43)	41.9% (31)	46.3% (74)
Cohesive	51.2% (42)	48.8% (40)	51.3% (82)
No distinction	1.25% (2)	1.25% (2)	2.5% (4)
Total	53.6% (87)	43.7% (73)	100.0% (160)

Results show that 46.3% of the respondents saw mathematics as a fragmented body of knowledge while more than half of them (51.3%) regarded the subject as a complex, logical system, which provides insights for understanding the world. Furthermore, along gender line, it is seen that the percentage of males in the fragmented class (58.1%) was far higher than that of the cohesive class (51.2%), whereas, for the females it was the other way round, which is, 48.8% and 41.9% in the cohesive and fragmented categories, respectively. It was found that 4 of the respondents rated cohesive and fragmented classes equally. To establish whether there is significant difference in the conception of mathematics based on gender.

T – test was computed. It was found that at $p < 0.05$ conception of mathematics is not significantly influenced by gender. Means and standard deviation for the male and female respondents are given respectively [$M = 46.33$, $S.D = 10.537$] while female [$M = 46.56$, $S.D = 8.665$].

Discussion

Mathematics anxiety is a serious and pervasive problem especially in a school setting. It can be a disabling condition causing humiliation, resentment and even panic. Students often develop mathematical anxiety in schools often as a result of learning from teachers who are themselves anxious about their mathematical abilities in certain areas. Students may experience mathematics anxiety in many forms and degrees, from “freezing up” during a mathematics examination to attempting to avoid anything having to do with numbers. The samples used for this study are the pre-service teachers whose peculiarity was the fact that all of them must compulsorily offer mathematics courses at 100 level irrespective of their departments. Incidentally, the result of this study indicated that majority of the respondents (72.5%) had very high mathematics anxiety which may consequently affect their achievement in mathematics. As pointed out by Trujilo and Hadfield (1999) that negative school experience, lack of family support and general test anxiety may be responsible as there are economic hardships experienced by many students where many of the them had to struggle to pay their school fees. However, this result is contrary to Arigbabu (2006) who reported that mathematics anxiety is not well pronounced among pre-service teachers, in the sample data, however this may be due to the fact that respondents varied in their characteristics from time to time and place to place based on their environmental and social background. It is however compatible with what the study reported for the non-mathematics majors which exhibited statistically significant higher level of anxiety than the mathematics majors. This result is also in accordance with the view of Harper and Daane, (1998) and Hembree (1990) that mathematics anxiety was prevalent amongst pre-service teachers.

Again, result indicated that majority of the study male participants rated fragmented conception higher than cohesive. This is contrary to the report of Arigbabu (2007) that respondents in the study sample rated cohesive conception more than fragmented. The result in this present study is however not heart warming since it implies that the respondents, who are indeed pre-service teachers, saw mathematics as a fragmented body of knowledge rather than as a complex, logical system, which provides insights for understanding the world of the respondents. A very important factor in motivating children to study mathematics is for a teacher to stay positive about mathematics, if possible, enthusiastic, but when the pre-service teachers are having a wrong conception of the subject, it will be very disastrous. Furthermore, another difference in mathematics abilities often explored in research concerns gender disparities. It is thought that women experience more anxiety in mathematics as a group than

men, however, the results of this study indicated that mathematics anxiety is not influenced by gender. This result corroborates the finding of Arigbabu (2007) who reported no gender difference in mathematics anxiety in Nigerian sample of prospective teachers, indicating that mathematics anxiety is gender invariant, that is, mathematics anxiety is not influenced by gender among respondents. This result is in line with (Arigbabu and Mji, 2005) who reported no gender influence on conception about mathematics held by respondents. Considering the male and female respondents as the educational leaders of tomorrow this result is indeed a pleasant development in the mathematics environment as it shows that mathematics conception is gender invariant.

Recommendation: It is noticed from the results that majority of pre-service teachers had high mathematics anxiety, it is therefore recommended that deliberate effort should be made to encourage students and give proper counselling to them on how to develop positive attitude towards mathematics particularly at the foundation level. Consequently one of the easiest ways to reduce math anxiety is for the parent to be more involved in their child's education. Also, teaching programmes should reinforce positive attitude towards mathematics, accommodate different learning styles and allowing training of students in such a way that they could develop a mathematics conception that will be cohesive.

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