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Full Length Research Paper

Mathematics anxiety among engineering students and its relationship with achievement in calculus

Garba Sahabi Adamu

Department of Mathematics, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria

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This paper analyzed the relationship between Mathematics Anxiety and Calculus Achievement among engineering students. The sample consists of 148 (116 males and 32 females) year one students of Waziri Umaru Federal Polytechnic, Birnin, Kebbi. Pearson correlation, paired samples t-test and Independent sample t-test were used to analyze data using SPSS version 20.0. The results obtained showed that Mathematics anxiety has insignificant negative correlation with Calculus achievement. It was also gathered that gender difference in Mathematics anxiety is significant while gender difference in Calculus achievement is not significant. Females exhibit high anxiety than males.

Key words: Mathematics anxiety, calculus, Mathematics performance, achievement.

INTRODUCTION

Richardson and Suinn (1972) defined Mathematics anxiety in terms of its (debilitating) effects on Mathematics performance. They observed that the feeling of tension and anxiety interferes with manipulation and solving of Mathematical problems in a wide variety of ordinary life and academic situations. Mathematics anxiety affects students' confidence in Mathematics. Many students who suffer from Mathematics anxiety have little confidence in their ability to do Mathematics and tend to take the minimum number of required Mathematics courses, greatly limiting their career choice options (Garry, 2005). Mathematics anxiety involves a feeling of tension and apprehension about performing Mathematics and is associated with delayed acquisition of core Mathematics and number concepts and poor Mathematics competence. It can be viewed as a situation of discomfort observed during working on Mathematical problems (Hadfield and Trujillo, 1999).Tobias and Weisbrod (1980) described Mathematics anxiety as the "the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a Mathematical problem. Smith (1997) listed a varied characteristics of Mathematics anxiety that include uneasiness when asked to perform mathematically, avoidance of Mathematics classes, feeling of physical illness, faintness, dread or panic, inability to perform on a test and utilization of tutoring sessions that provide very little success. Anxiety situation is associated with fear and apprehension to specific Mathematics related situations such as applied Calculus (D'Ailley and Bergering, 1992).

Baloglu and Kocak (2006) outlined three major factors that cause Mathematics anxiety, namely, Dispositional, situational and environmental factors. The dispositional factors are concerned with psychological and emotional features such as; attitudes towards Mathematics, self-concept and learning styles. The self concept refers to students' perception of their own ability to perform well in Mathematics and to learn new topics. The situational factors are direct features that result from their particular Mathematics courses, the nature of the course, and how it is designed and carried out, pace of instruction, etc. The environmental factors are characteristics that affect the students prior to their Mathematics course; for instance, age, gender, academic major, and previous Mathematics experience.

Socio economic background may interfere with the level of Mathematics anxiety of the students at various

E-mail: abujabaka2@yahoo.com. Tel: +2348063496230.

levels.

Parents' educational level, income, age, and the school type are good predictors of Mathematics anxiety (Mahigir et al., 2012).

Mathematics anxiety may be as a result of past experience by the learner. Freedman (2003) defined Mathematics anxiety as "an emotional reaction to Mathematics based on a past unpleasant experience which harms future learning". Mathematics anxiety is an outcome of low self esteem and fear of failure. It causes problems for processing the next oncoming information as well as in using previously learned information for problem solving. Such students tend to avoid Mathematics whenever or wherever possible (Daane et al., 1986). Mathematics anxiety is found to affect teaching and learning (Wigfield and Meece, 1988). Students that are bored and apprehensive towards Mathematics may tend to avoid Calculus. This is due to adverse emotional reaction of the students towards the subject (Henbree, 1990). Mathematics anxiety is often viewed from a deficit perspective through which it explains a lack of demonstrable mathematical ability. For instance, it is defined as a restrictive influence on successful working with numbers and problem solving (Furner and Berman, 2003).

Mathematics anxiety was found to affect the academic achievement in Mathematics of the students. According to Karimi and Venkatesan, (2009), there is a relationship between Mathematics anxiety, mathematics performance and academic hardness in high school students. Their findings revealed that Mathematics anxiety has significant negative correlation with Mathematics performance. They also reported a significant gender difference in Mathematics anxiety. They also reported no significant difference between boys and girls in Mathematics performance. They also suggest that the performance of students in Mathematics can be influenced by Mathematics anxiety. Correlation between Mathematics anxiety and Mathematics performance is a construct that attracts comments and researches. According to Pourmasleme et al. (2013), a significant correlation was observed between high level anxiety and low academic performance. Significant difference between males and females in Mathematics anxiety was also reported.

Gender difference is a phenomenon that continues to attract attention in almost all fields that affect our daily lives. In engineering, there is a wide gap in participation between males and females. There is a mark difference between males and females who obtained degrees or higher national diploma in engineering and technology in Nigerian institutions (Badekale, 2003). Research has indicated a significant difference in Mathematics anxiety between males and females. In other words, females exhibit higher Mathematics anxiety than males (Pourmoslemi et al., 2013). However, Achor et al. (2010) found no significant difference in achievement and interest in geometry between males and females. This may be a pointer that gender difference mentioned above may not be related to Mathematics in Engineering. A similar research by Moses and Daniel (2008) found a disappearing gap between males and females in Integrated Science.

Background of the study

Calculus is imperative to science, engineering and technology. Applications of calculus in engineering problems are diverse; therefore students of engineering are expected to study it rigorously for effective application. Examination results have shown that students of engineering at Waziri Umaru Federal Polytechnic exhibit some weakness in calculus during semester examinations of 2010/2011 and 2011/2012 sessions with mean score of 51.23 and 47.52% respectively. This study seeks to examine the relationship between Mathematics anxiety and students' achievement in Calculus. Gender stereotype in calculus will also be examined.

Research hypotheses

Three hypotheses are to be tested in this study, namely;

i. There is relationship between Mathematics anxiety and calculus achievement.
ii. There is significant difference between males and females in Mathematics anxiety.
iii. There is significant difference in calculus performance between males and females.

METHODOLOGY

The population of this study is the entire year one (i.e., ND 1) students of College of Engineering of the Waziri Umaru Federal Polytechnic, Birnin Kebbi (n < 400). A sample of one hundred and forty eight (148) students was randomly selected using simple random sampling. The sample comprised 32 or 21.62% females and 116 or 78.38% males. The instruments used for data collection are Mathematics Anxiety Scale (MAS) and Calculus Achievement Test (CAT). The MAS is an abbreviated Mathematics anxiety instrument that has 14 items designed to measure the Mathematics anxiety of college students (Mahmood and Khatoon, 2011). The MAS is a two dimensional and short instrument where seven items were worded positively and seven items, worded negatively. Mathematics anxiety score is calculated by adding the individual scores of all the items together whose possible range is between 14 – 70. High score on the MAS indicates a high level of mathematics anxiety; that is the reason the score is reversed. The instrument uses a 5 point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) for positive items and 5 (strongly agree) to 1 (strongly disagree) for negative items. The MAS has split half reliability of 0.89 and Cronbach's alpha 0.87. CAT is a 10 questions essay type test; the items on this instrument are based on three cognitive levels of knowledge, understanding and application. The test items are scored manually, each question answered correctly attracts a total score of 10 marks. Thus the highest mark obtainable is 100 and least mark obtainable is zero. The level of performance of a student is taken as student's total test score.

RESULTS

The analysis of data was carried out using SPSS version 20. Three factors were analyzed;

Gender difference in Mathematics anxiety, Calculus Achievement and relationship between Mathematics anxiety and Calculus achievement.

i. *Gender Difference in Mathematics anxiety.*

An independent samples t-test was conducted to examine whether there was a significant difference in Mathematics anxiety between males and females. The test revealed a statistically significant difference between males and females ($t = – 3.979$, $df = 146$, $p < 0.01$). Females (Mean = 45.28, SD = 9.77) reported significantly higher level of anxiety than males (mean 37.12, SD = 10.40).

ii. *Gender Difference in Calculus Performance.*

Also, an independent samples t-test was carried out to examine if there was a significant difference in Calculus performance between males and females. The test results revealed a statistically insignificant difference in calculus performance between males and females ($t = 1.88$, $df = 146$, $p > 0.01$). Males (mean 39.24, SD = 17.82) reported insignificantly higher performance than females (Mean = 32.72, SD = 15.81).

iii. *Relationship between Calculus Anxiety and Calculus Achievement (males and females combined)*

A bivariate correlation test was conducted to calculate the Pearson correlation coefficient between Mathematics anxiety and Calculus performance. The results obtained indicated a weak negative correlation between Mathematics anxiety and Calculus performance ($r = – 0.036$, $p > 0.01$). Also, a paired samples statistics produced non significant correlation ($t = 0.613$, $df = 147$, $p > 0.01$, $r = -0.036$). Mathematics anxiety (mean = 38.89, SD = 10.77) and Calculus performance (mean = 37.83, SD = 17.55).

iv. *Relationship between Calculus Anxiety and Calculus Achievement (males only)* Paired sample test and bivariate correlation test on the male scores produced the Pearson correlation coefficient ($r = 0.041$, $t = – 1.127$, $df = 115$, $P > 0.05$). This indicates a weak positive correlation.

v. *Relationship between Calculus Anxiety and Calculus Achievement (females only)*

Paired sample test and bivariate correlation test on the male scores produced the Pearson correlation coefficient ($r = – 0.109$, $t = 3.652$, $df = 31$, $P < 0.01$). This indicates a significant negative correlation.

DISCUSSION

The results of the data analysis showed a significant difference in Mathematics Anxiety between males and females. The computed means and standard deviations indicated that females have higher anxiety in Mathematics than their male counterpart. This confirms the previous researches which report higher Mathematics anxiety of females than males. (Yezici and Ertekin, 2010; Maloney et al., 2012; Wigfield and Meece, 1988). According to the results obtained in this study, there is no significant difference in Calculus performance between males and females. This is parallel to the previous finding (Penner and Paret, 2008; Eriksson and Lindholm, 2007; Else-Quest et al., 2010). The overall average performance was less than forty (37.8). A weak negative correlation between Mathematics anxiety and Calculus performance was observed. This indicates a very weak relationship between Mathematics anxiety and students' performance in calculus. This contradicts the hypothesis that there is relationship between Mathematics anxiety and Calculus achievement among the students. This result is opposed to the findings that reported a significant relationship between Mathematics Anxiety and Mathematics Performance (Ashcraft and Kirk, 2001; Karemi and Venkatesan, 2009). When males' and females' results were analyzed separately, two different outcomes were observed. For males, an insignificant weak positive correlation was observed and a negative significant correlation was indicated in females.

CONCLUSION AND RECOMMENDATIONS

This study was able to reveal the relationship between Mathematics Anxiety and Calculus Achievement. There is an insignificant positive correlation between Mathematics Anxiety and Calculus Achievement in males. The study also revealed significant negative correlation between Mathematics Anxiety and Calculus Achievement in females. Conclusively, there is a negative weak correlation between Mathematics anxiety and Calculus performance in both groups of students. The mean anxiety in females is higher than that of males. This indicates that there is a significant difference in Mathematics anxiety between males and females. There is no significant difference in the Calculus performance between males and females. Generally, the performance in calculus was below average according to this result.

Teachers are expected to modify their approach in teaching to make it friendly and practically oriented. Psychological aid should also be given to complement the method of teaching. Further research should be conducted on anxiety in different areas of Mathematics and

other academic levels.

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