REDUCING MATHEMATICS ANXIETY AMONG STUDENTS WITH PSEUDO-DYSCALCULIA IN IBADAN THROUGH NUMERICAL COGNITION AND EMOTIONAL FREEDOM TECHNIQUES: MODERATING EFFECT OF MATHEMATICS EFFICACY

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ABSTRACT

Anxiety in mathematics is a critical challenge facing secondary school students in Nigeria. Previous studies with focus on the improvement of this challenge are scarce. Specifically, there is paucity of studies using Numerical Cognition and Emotional Freedom techniques in solving the above challenges, This study therefore investigated the effects of numerical cognition and emotional freedom techniques on mathematics anxiety among non-science students with pseudo-dyscalculia in Oyo State. Pretest, post-test, control group quasi experimental design was adopted for the study. One hundred and two students were sampled through simple random sampling. Mathematics Anxiety Scale (α = 0.89), Mathematics Efficacy (α = 0.86) and Pseudo-dyscalculia scale (α = 0.93) were administered to obtain data for the study. Therapeutic packages used for the intervention were Numerical Cognition and Emotional Freedom. Seven hypotheses were tested at 0.01 level of significance. Data was analysed using Analysis of Covariance (ANCOVA). The study revealed main effect of treatment on Mathematics Anxiety; F (2,109) = 173.020, p<.01. Meridian-Based intervention was more effective (mean = 33.78) than Numerical cognition (mean = 45.35) in the reduction of Mathematics anxiety. There was significant main effect ; F(1, 109 = 21.00, p<.01); interactive effect F(2, 109 = 6.116, p<.01 of mathematics efficacy and Treatment on mathematics anxiety of the participants. The two packages were effective in reducing mathematics anxiety among the participants. Based on the findings, Educational Psychologists, Counselling Psychologist and other educational related bodies could adopt the packages for educational diagnosis to improve academic performance of students with academic phobia.

Key words: *Numerical Cognition, Emotional Freedom (Meridian-based Intervention), Mathematics Efficacy, Mathematics Anxiety, Pseudo-dyscalculia*

Introduction

The place of Mathematics in the life of any nation is one which is inextricably linked with development in that nation (Okereke, 2002, cited in Anaduaka, 2008). Indeed no nation that wants to develop scientifically and technologically neglects the Mathematical component of her school curriculum. The increasing attention given to Mathematics stem from the fact that without Mathematics there is no science, without science there is no modern technology, and without modern technology, there is no modern society (Salau, 2002, cited in Anaduaka, 2008). Despite the relative importance of Mathematics, it is very disappointing to note that students' achievement in the subject has remained consistently poor. Statistics abound to show that mass failure in Mathematics especially in the Senior Secondary Certificate Examination (SSCE) is real and that the trend of students' performance has been on the decline (Agwagah, 2001; Arnazigo, 2000; Betiku, 2002; Salau 2002; WAEC, 1990, 2000, 2004, 2006, NECO, 2010).

A lot of researches have been carried out to ascertain the root causes of mathematics anxiety and to proffer solutions. Consequently, research efforts geared towards finding reasons and possible solutions for the problems have not yielded much positive effect, as the result analysis for the 2006, 2009 SSCE and NECO 2010 revealed that only fifteen percent of the candidates qualified for university admission with credits in five subjects which includes English and Mathematics (WAEC, 2006, 2009; NECO 2010). Byrd in Aprebo (2002) asserted that poor achievement in Mathematics emanated from anxiety and fear. Mathematics phobia, he said, has been an academic disease whose symptoms are always expressed on the faces of the learners in the Mathematics classroom. Mathematics anxiety is one of the most serious limitations to education. Many children and young adults develop a fear for Mathematics while they are in school. Mathematics anxiety affects many individuals through feelings of tension, apprehension, or fear that interfere with the manipulation of numbers and the solving of Mathematics problems in a wide variety of

ordinary life and academic situations (Ashcraft, 2002). Mathematics is considered as one of the toughest subjects by majority of students (in Anaduaka, 2008). There are very few students in the classroom who really love to learn and explore Mathematical concepts (Ashcraft, 2002).

Bamidele (2005) stated that in Nigerian schools, students' general impression is that Mathematics is a dreadful subject. But ironically, this subject is the basis for scientific and technological advancement of any country. Mathematics anxiety is an intense emotional feeling of anxiety that people have about their ability to understand and do Mathematics. People who suffer from Mathematics anxiety feel that they are incapable of doing activities and participating effectively in classes that involve Mathematics. Some Mathematics anxious people even have a fear of Mathematics called *pseudo-dyscalculia*, which is described as false belief in Mathematics disability caused by lack of, inconsistent, poor, or inappropriate systematic Mathematics instruction; inattention, fear, anxiety, or emotion. Many students often choose their courses in the universities on the basis of how little Mathematics is required for the degree (Anaduaka, 2008). Some students may even experience worse problems when they find out that their alternative degree they put in for have some courses that require Mathematics orientation like Statistics. By this, some students find it very difficult to cope with Statistics, some try to readjust, while others resign to fate. Mathematics anxiety is an emotional, rather than intellectual problem because the problem emanates from inconsistent emotion and therefore interferes with a person's ability to learn Mathematics which later results in an intellectual problem (Ashcraft, 2002).

Mathematics efficacy is the judgments that students make about their potential to learn successfully well in Mathematics and the belief in their own capabilities. The choices people make; the efforts they put forth, and how long they persist are influenced by self-efficacy (Bandura, 1997; Schunk, 1996). According to Bandura, every individual possesses a belief system that exerts control over his/her thoughts, emotions and actions. Among the various mechanisms of human agency, none is more central or pervasive than self-efficacy beliefs (Bandura & Locke, 2003; Pajares, 2000). Expectations about doing well in Mathematics (confidence) relates closely to one's beliefs about personal capabilities for successfully performing domain-specific tasks (self-efficacy). Students with higher levels of Mathematics efficacy higher goals, apply more effort, persist longer in the face of difficulty and are more likely to use self-regulated learning strategies (Wolters & Rosenthal, 2000). If students are able to perform a task successfully, then their self-efficacy can be raised. In contrast, if students are not able to perform a task, then they may believe that they do not have the skills to do the task which, in turn, lowers their self-efficacy.Numerical Cognition is a sub-discipline of cognitive science that studies the cognitive, developmental and neural bases of numbers and Mathematics. It deals with how students acquire an understanding of numbers, and how much is inborn. It also has to do with how humans associate linguistic symbols with numerical quantities. Numerical Cognition perspective emphasizes that participants can become stuck by focusing on their past and current bad behavior and failures versus focusing on future solutions. Students accomplish more when they concentrate on their successes and strengths rather than their failures and deficits. There are so many advantages for students who know how to constructively solve problems. Students should be looked at as being good and capable of rational thought but without any influence from teachers or significant adults a student will likely focus more on their own negative side (Zopp, 1999).

Numerical Cognition pursues the positive self statement and students are more likely to find a solution to a problem when they concentrate on their successes rather than their failures. Students must realize that they play a huge part in the success of their problem solving process and that change will occur. Once the changes begin to happen then the student will realize that their lives can be very different. Then it is time to have the students set goals and then monitor their progress. The therapist will then try to use comprehension strategies to translate the linguistic and numerical information in the problem and come up

with a solution. For example, the therapist may read the problem more than once and may reread parts of the problem as they progress and think through the problem.

Emotional Freedom Techniques (EFT) is a meridian based intervention, a psychotherapeutic tool to relieve many psychological conditions, including anxiety, low achievement and other psychopathology like depression, post traumatic stress disorders, stress, addictions and phobias (Feinstein, 2005). The basic EFT technique involves holding a disturbing memory or emotion in mental focus and simultaneously using the fingers to tap on a series of twelve specific points on the body (Rowe, 2004). The theory behind EFT is that negative emotions are caused by disturbances in the body's energy field (Swingle, 2000). Human thoughts are constantly creating patterns of electrical energy that cause the release of neurotransmitters, hormones and other chemicals in the body that people feel as emotions. Students who have Mathematics disabilities have negative emotions which are unhelpful thoughts and beliefs, and are significant factors in the development of depression, anxiety, anger, low self-esteem, self-defeating behaviours, difficulty with coping, negative emotion and lack of Mathematics efficacy. When there is a disruption in the body's electrical flow, such as the fight or flight response, humans feel it. If the disruption continues, it can lead to emotional distress and eventually physical problems. When the disruption is removed, the distress stops (Swingle, 2000).

The EFT in solving Mathematics anxiety and phobias involve redirecting the old thought patterns or response mechanisms of anxious or phobic people to the subject or teacher they have a phobia or anxiety about and basically creating a new set of more useful patterns or mechanisms of behaviour to replace the old phobic response. There has to be acceptance that despite the phobic condition, the person is loved or he or she loves himself or herself. Eventually, the fear or fright will be replaced by curiosity and there will be lesser resistance and anxiety (Swingle, 2000). Reduction of Mathematics anxiety through Numerical-Cognition and Emotional Freedom Techniques appear to be scarce. This study would therefore expand the frontiers of knowledge on Numerical Cognition and Emotional Freedom Techniques in reducing Mathematics anxiety and enhancing Mathematics achievement among non-science students with fear of Mathematics. Participants in this study would be trained with Numerical Cognition Strategy and Emotional Freedom Techniques to reduce anxiety in Mathematics and enhance Mathematics achievement. It is believed that when students are trained to reduce their anxiety in the Mathematics, their achievement will be more enhanced, thereby helping students to acknowledge the fact that their problems in the subject have to do with their cognition and negative emotion and therefore will be prepared to restructure it and build confidence in them.

Although Numerical Cognition Technique has been used by researchers to treat Mathematics Anxiety in the past, yet most of these studies only see Mathematics problems among students as intellectual rather than emotional problems. Therefore, the intellectual problem in Mathematics is a result of negative emotion towards the subject, probably from the teachers that take the subject or lack of motivation by the significant others. In this case, the present study has combined Emotional Freedom Technique together with Numerical Cognition in order to also deal with emotional problems or phobias that students have for Mathematics.

Literature

Numerical Cognition and Mathematics Anxiety

There is paucity of literature on numerical cognition and Mathematics anxiety. So there is no much available literatures on the domain of behaviour. In a study by Hopko *et al* (1999) it was found that Mathematics-anxious individuals have a deficient inhibition mechanism whereby working memory resources are consumed by task-irrelevant distracters. A consequence of this deficiency was that explicit memory performance was poorer for high-anxious individuals. They also found no relationship between competence

and Mathematics anxiety. There are a great many causes postulated for Mathematics anxiety. In a study of eight adult learners, Zopp (1999) found that unrelated life events, trigger events in education and a lack of support contributed to Mathematics anxiety in her subjects.

Ashcraft and Faust (1994; also Faust, Ashcraft, & Fleck, 1996) have shown that high-Mathematics-anxiety participants have particular difficulty on two-column addition problems, owing largely to the carry operation. When such problems were answered correctly, the time estimate for the embedded carry operation was nearly three times as long for high-anxiety participants as it was for low-anxiety participants (Faust *et al*., 1996). Thus, high-Mathematics-anxiety participants showed slower, more effortful processing on a procedural aspect of performance, performing the carry operation (for suggestive evidence on Mathematics affect and procedural performance in a numerical estimation task, (LeFevre, Greenham, & Waheed, 1993).

Emotional Freedom Technique and Mathematics Anxiety

Daniel, Brenor, Karen and Loren (2005) explored test anxiety benefits of Wholistic Hybrid derived from Emotional Freedom Techniques (EFT), and Cognitive Behavioral Therapy. Participants include Canadian university students with severe or moderate test anxiety. A double-blind, controlled trial of EFT, and CBT was conducted. Standardized anxiety measures included the Test Anxiety Inventory (TAI) and Hopkins Symptom Checklist (HSCL-21). The result of their study showed that Emotional Freedom Technique was better than Cognitive Behavioural Technique. In only two sessions WHEE and EFT achieved the equivalent benefits to those achieved by CBT in five sessions. Participants reported high satisfaction with all treatments. EFT and WHEE students successfully transferred their self-treatment skills to other stressful areas of their lives.

Nilhan and Bahar (2006) investigated the effect of EFT on test anxiety , a brief exposure therapy with somatic and cognitive components. A group of 312 high school students enrolled at a private academy was evaluated using the Test Anxiety Inventory (TAI), which contains subscales for worry and emotionality. Scores for 70 demonstrated high levels of test anxiety; these students were randomized into control and experimental groups. A statistically significant decrease occurred in the test anxiety scores of both the experimental and control groups. The EFT group had a significantly greater decrease than the PMR group. The scores of the EFT group were lower on the emotionality and worry subscales. Both groups scored higher on the test examinations after treatment; though the improvement was greater for the EFT group, the difference was not statistically significant.

Mathematics Efficacy and Mathematics Anxiety

In one study of 350 college students, Pajares and Miller (1994c) examined the hypothesized mediational role and predictive power of self-efficacy in Mathematics problem solving. Using previously validated measures, the researchers ran several Mathematics-related independent variables in relation to Mathematics problem solving. Results show that self-efficacy held greater predictive power for problem solving success than did Mathematics self-concept, background in Mathematics, perceived usefulness of Mathematics, and gender. The effects of background and gender, however, were significantly related to self-efficacy, supporting Bandura's assertion of the mediational role of self-efficacy on performance. Simply put, background and gender are not independently strong predictors of Mathematics performance, but they are influential sources of Mathematics self-efficacy which is highly predictive and plays a strong mediational role on performance.

Self-efficacy is a domain-specific construct in academics. Many, including Bandura, argue that it is also task-specific, and attempts to measure self-efficacy at the domain level often result in ambiguous or uninterpretable results (Bandura, 1986; Pajares & Miller, 1994c, 1995). Many of the studies that show self-efficacy to account for lesser variance than other personal determinants often stray from Bandura's prescriptions for a microanalytic strategy. Often these studies assess self-efficacy globally with just a few scale items; that is, they ask

participants to report on their confidence or efficacy with regard to a specific academic domain, and not a specific performance task. At this level of self-reporting, it is expected that self-efficacy cannot reliably be separated from other personal determinants such as self-concept, anxiety, self-confidence, and background. It thus raises the question of whether one is actually measuring self-efficacy, or more generally measuring attitudes and other common mechanisms toward a given academic domain. Of course, the latter are important in some areas of educational research, but do not always give sufficient evaluative information for performance on specific, criteria tasks. One possible lens from which to view self-efficacy within the context of instructional technology is to consider one's judgments of personal capabilities to authentically accomplish a specific performance objective. Self-efficacy and performance are inextricably related, and in the domain of Mathematics both are often correlated with gender.

Hypotheses

The following hypotheses were tested for the purpose of this study at 0.01 level of significance.

1. There will be significant main effect of Numerical Cognition, Emotional Freedom techniques and control group on mathematics anxiety of secondary school students.
2. There will be significant main effect of mathematics efficacy on mathematics anxiety test score of secondary school students.
3. There will be significant interactive effect of the therapeutic packages and mathematics efficacy on mathematics anxiety test score of secondary school students.

Research Design

The study adopted a pre-test post-test control group design using a 3 x 2 matrix. The matrix consists of the three experimental groups (Numerical cognition, Meridian Based intervention and control) and Mathematics efficacy of the participants varying at two levels: high and low.

Population

The target population for this study consisted of the senior secondary students (SS1) in some selected public secondary schools in Ibadan who had consistent records of low achievement in Mathematics. These records were obtained from the schools of the study's participants with the permission and cooperation of the school authorities. These records were obtained from at least three sessions of academic records of the identified participants. This category of students was just transited from junior secondary with choice of class classified as Commercial, Art and Science.

Participants

The sample for this study comprised one hundred and twenty (120) Senior Secondary One (SS I) students drawn from three selected public secondary schools in Ibadan. Final selection of participants was preceded by a preliminary investigation for selecting the low achievers in Mathematics in the three secondary schools that were used for the experiment.

All the schools operate a common policy of conducting two continuous assessment tests each term of the session totaling six continuous assessment scores. All schools also conduct the end-of-term examination making up three examinations. The two continuous assessment scores have a weight of 40%, while the terminal examination has a weight of 60% totaling 100% for each candidate in every subject offered. At the end of the session, the average of the three terms scores are computed for each student to determine suitability for promotion. This practice of cumulating and averaging offers a consistent picture of each

student's academic status as to whether he/she is high, average or low in the subject. What was your inclusion criteria?

Sampling technique
The researchers adopted simple random sampling technique for the study.

Procedure
The research experiment spanned through a period of ten weeks during which time there was researcher-participants' interaction. There were four main phases: randomization, pretest, treatment and post-treatment evaluations. Permission was sought and obtained to involve both staff and students in the study. Accordingly, the principals assigned members of staff and school counselors who could assist the researcher. A pseudo-dyscalculia scale was used to identify people with mathematics phobia. Mathematics efficacy scale was used to identify those students with high and low mathematics efficacy. The researcher and his assistants met and agreed on the day of the wee and time for the therapeutic sessions in each of the schools where there were sessions.

Objectives of the therapeutic packages
The objectives of the treatment sessions are:

- To enable participants identify what actually lead to their anxiety in mathematics and help them reduce such.
- To enhance mathematics efficacy of participants and thus reduce their state of learned helplessness.
- To equip participants with learning skills in order to improve their academic performance in the subject.
- To reduce negative emotions of the students in mathematics.
- To enable the students to restructure their bad cognition and emotion with positive self statements in mathematics.
- To help the participants learn self-respect and self-esteem in mathematics.
- To enable them overcome feelings of helplessness in mathematics.
- To promote a generalized sense of capability in the subject.
- To equip students with the right problem solving skills in mathematics.

Instrumentation
The four assessment scales that were used in this study are Mathematics Anxiety Scale (MAS), Mathematics Efficacy Scale (MES), Mathematics Achievement Test and Pseudo-dyscalculia Scale (PDS).

Mathematics Anxiety Scale
Mathematics Anxiety Scale was a paper and pencil psychological instrument developed by Betz (1978) with coefficient alpha of 0.90 to assess students' Mathematics Anxiety level. The items include statements on the factors to which students attribute their predicaments in Mathematics. It was a 14-item scale with response format ranging from strongly agree = 5 to strongly disagree = 1. Participants respond by ticking the option that best describes their Mathematics Anxiety level. The items were added to give a total score of 70 and a minimum of 14. A score of 42 and above reveals that the participants' Mathematics Anxiety is high, while a score below 42reveals low anxiety. The items were coded because there were both positive and negative statements which were reversed. The psychometric property of the instrument was established through a pilot study on a sample of 30 students. The Cronbach Coefficient observed was 0.89 and internal consistency of the instrument ranges between 0.46 and 0.75. The scale was adapted to suit the culture of the participants by ensuring its face and content validity by the researcher's supervisor.

Mathematics Efficacy Scale

The Mathematics Efficacy Scale was adapted from Betz and Hackett (1983) with coefficient alpha of 0.88. The version adapted by the researcher was tailored for use in the Nigerian Secondary Schools students. It spans such areas as: problem-solving; performance accomplishment; verbal persuasion and other areas of mathematical abilities. The scale comprises 16 items spread over two sections A and B with A containing personal information and B containing items on Mathematics Efficacy. The items were scored as follows: Strongly Agree = 5, Agree = 4, Not sure = 3, Disagree = 2 and Strongly Disagree = 1. The points that were scored on all items were summed up to give participant's score on the scale. The items were also coded because there were both negative and positive statements which was be reversed. Scores on the scale ranged between 16 and 80. A score above 48 indicated high Mathematics-efficacy and score below the norm indicated low Mathematics-efficacy. The psychometric property of the instrument was established through a pilot study on a sample of 30 students. The Cronbach Coefficient Alpha of 0.86 was observed with internal consistency ranging between 0.46 and 0.69.

Pseudo-dyscalculia Scale

This measuring instrument was also developed by the researcher. This has to do with 40-item instrument that measure individual's false belief in mathematical skills. This scale was used to identify participants with pseudo-dyscalculia or false belief in Mathematics. A norm was established to indicate participants who have high and low pseudo-dyscalculia. Participants with high pseudo-dyscalculia would be used for the study while those with low pseudo dyscalculia would be dropped. Psychometric properties of the scale were established on a sample of 30 students. Reliability techniques were Cronbach Coefficient Alpha, and Split half reliability. Method of validity involved content, convergence construct, discriminant and concurrent validity. The Factor analysis was used to establish the factor structure of the scale. Principal component analysis was used with Varimax Rotation, iteration method and Kaiser Normalization. Eigen value was determined and overall variance of the scale was observed. The initial coefficient alpha was 0.67. The analysis removed 14 items that were not internally consistent (items with less than 0.3) and this increased the overall coefficient to 0.88. After this procedure, some items (8 items) still reported negative correlation and removed. This later increased the coefficient to 0.93. The Correlation between forms from the split half method was 0.79, Equal length Spearman Brown was 0.84, Unequal length was also 0.86, Guttman Split-half was 0.88, Alpha for part 1 was 0.79, alpha for part 2 was 0.80. Factor analysis was carried out using extraction method (Principal Component Analysis). The overall total variance explained was 61.76% meaning that the scale describes the domain of behaviour. The initial eigen-values were between 0.54 and 4.763. Three components were extracted initially using extraction method of principal component analysis. The factors were later rotated using varimax with Kaiser Normalization. The rotation converged in 8 iterations and all factors: False beliefs, environmental factors, inappropriate concentration, fear or anxiety, negative emotion, avoidance, inability to follow systematic instruction and low self efficacy were loaded in factor 1 (Pseudo dyscalculia). The correlations between the initial and extraction were between 0.51 and 0.68 meaning that the items are really describing the domain of behaviour.

RESULTS

This chapter presents the result of the findings of data collected from the participants of the study. Sixteen hypotheses were stated in this study and were tested using Analysis of Covariance (ANCOVA) at 0.01 level of significance. The summaries of the analyses were presented in tables for each of the hypotheses.

Hypothesis one: There is no significant main effect of treatment on mathematics anxiety of secondary school students

Table 1 : Summary of a 3 x 2 Analysis of Covariance (ANCOVA) on the treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	30016.519[a]	10	3001.652	59.135	.000	.844
Intercept	90.738	1	90.738	1.788	.184	.016
premath_anx	6744.220	1	6744.220	132.866	.000	.549
Group	17564.828	2	8782.414	173.020	.000	.760
mathefficacy_lev	1775.207	1	1775.207	34.973	.000	.243
group * mathefficacy_lev	1339.741	1	1339.741	26.394	.000	.195
Error	5532.781	109	50.759			
Total	319568.000	120				
Corrected Total	35549.300	119				

Table 1 reveals that there was a significant main effect of treatment (Numerical Cognition, Meridian Based Intervention and Control group) on Mathematics anxiety of secondary school students; ($F_{(2,109)}$ =173.020, p<0.001, Partial Eta Squared=.760).Therefore the null hypothesis is rejected. The table further reveals that the groups had large effect on the mathematics anxiety posttest score variations, which implies that the differences in the groups accounted for 76% (Partial Eta Squared=.760) in the variation of the posttest score. In order to provide some indicators of the performance of each group, a Multiple Classification Analysis was computed. The results are presented in table 4.7

Table 2: Multiple Classification Analysis (MCA) on post test Mean Score of Mathematics Anxiety

	N	Unadjusted Variation	Eta	Adjusted Variation	Beta
Source of variation					
Grand Mean=48.65					
Treatment Group					
1.Numerical cognition group	40	-3.3		- 9.27	
2.Meridian Based group	40	-14.87	.633	-15.2	.777
3.Control group	40	18.18		16.68	
Mathematic Self efficacy					
1 High	88	-4.31		1.51	
2 Low	32	11.85		-2.91	
Multiple R square					.844
Adjusted Multiple R square					.830

The MCA as shown in table 2 reveals that mathematics anxiety of all the participants exposed to meridian based technique had the least mean score (33.78), followed by Numerical cognition group (45.35) and control group which had the highest mean score (66.83).Since the treatment was meant to reduce students mathematics anxiety, the lesser the mean score the more effective the treatment. This therefore implies that in reducing students mathematics anxiety, Meridian based technique is more effective than Numerical cognition technique. However, to determine the actual source of the observed significance difference as indicated in the ANCOVA, Bonferonni Post-Hoc Test was carried out on the adjusted mean score of the groups, this is presented in table 3

Table 3: Bonferonni Post-Hoc Test (Pairwise Comparison) showing the nature of difference in students Mathematics anxiety

(I) intervention	(J) intervention	Mean Difference (I-J)	Std. Error	Sig.
Numerical Cognition Group	Meridian Based Group	5.481*	2.032	.024
	Control Group	-26.399*	2.079	.000
Meridian Based Group	Numerical Cognition Group	-5.481*	2.032	.024
	Control group	-31.880*	1.692	.000
Control Group	Numerical Cognition Group	26.399*	2.079	.000
	Meridian Based Group	31.880*	1.692	.000

Table 3 reveals that after controlling for the effect of pre-mathematics anxiety score. The posttest mathematics anxiety score of control group (mean=65.33) was significantly higher than that of the Numerical Cognition group (mean=38.93) and Meridian based group (mean=33.45). The intervention (Numerical Cognition) accounted for the reduction in the mathematics anxiety posttest score of the experimental group 1 (mean=26.399).While intervention (Meridian based) accounted for much more reduction in the mathematics anxiety posttest score of experimental group 2 (mean=31.88). This implies that the meridian-based intervention was more effective in reducing students' mathematics anxiety than numerical-cognition intervention. The coefficient of determination adjusted R-Squared= .830 revealed that the groups accounted for 83.0% in the overall variation of the mathematics anxiety test scores of the students.

Hypothesis two: There is no significant main effect of mathematics efficacy on mathematics anxiety test score of secondary school students

Table 1: shows that there was significant main effect of Mathematics efficacy on Mathematics anxiety of secondary school students; ($F_{(1,109)}$ =34.973, p<0.001, Partial Eta Squared=.243).Therefore the null hypothesis is rejected. The table further reveals that Mathematics efficacy had large effect on the mathematics anxiety posttest score variations, which implies that the differences in the level of mathematics efficacy accounted for 24.3% (Partial Eta Squared=.243) in the variation of the posttest score.

Hypothesis three: There is no significant interactive effect of treatment and mathematics efficacy on mathematics anxiety test score of secondary school students

Table 1 shows that there was significant interactive effect of treatment and mathematics efficacy on Mathematics anxiety of secondary school students; ($F_{(1,109)}$ =26.394, p<0.001, Partial Eta Squared=.195).Therefore the null hypothesis is rejected. The table further reveals that treatment and mathematics efficacy had large effect on the mathematics anxiety posttest score variations, that is, mathematics efficacy significantly moderated the influence of treatment on mathematics anxiety posttest score variances. This indicates that the differences that occur as a result of the interactive effect accounted for 19.5% (Partial Eta Squared=.195) in the variation of the posttest score. To further understand the point of difference the Bonferonni Post-Hoc Test
(Pairwise comparison) was computed.

Table 4: Bonferonni Post-Hoc Test (Pairwise Comparison) showing the nature of Difference in students Mathematics anxiety with respect to the interaction between intervention and mathematics efficacy.

				95% Confidence Interval	
Intervention	Math Efficacy Level	Mean	Std. Error	Lower Bound	Upper Bound
Numerical Cognition Group	High Efficacy	26.861	3.233	48.418	53.580
	Low Efficacy	50.999[a]	1.302	20.454	33.268
Meridian Based Group	high Efficacy	23.449[a]	1.140	31.190	35.708
	low Efficacy	53.67.[a,b]	1.013	36.901	22.762
Control Group	high Efficacy	64.614[a]	1.578	62.198	69.888
	low Efficacy	66.043[a]	1.940	61.486	67.741

Table 4 reveals that after controlling for the effect of pre-mathematics anxiety score. The posttest mathematics anxiety score of the three groups differ with respect to their level of mathematics efficacy except meridian group that did not record any score for student with low efficacy because all the students in the group displayed high mathematics efficacy after been exposed to the intervention. Comparing the level of mathematics anxiety posttest score of the three group among students with high mathematics efficacy; control group had the highest mathematics anxiety mean score (mean= 64.614), followed by Numerical Cognition group (mean=26.86) and Meridian Based group (mean= 23.449). The intervention (Numerical Cognition) accounted for the reduction in the mathematics anxiety posttest score of the experimental group 1 (mean=-37.754 $_{(26.86-64.614)}$).While intervention (Meridian based) accounted for much more reduction in the mathematics anxiety posttest score of experimental group 2 (mean=-41.165 $_{(23.449-64.614)}$). This implies that the meridian-based intervention was more effective in reducing mathematics anxiety score than numerical-cognition intervention especially among students with high mathematics efficacy.

Discussion

Hypothesis One

Hypothesis one, which stated that there is no significant main effect of treatment on Mathematics anxiety of secondary school students, was significant (see table 1). The findings revealed that the treatment effects were very effective in reducing Mathematics anxiety among the participants. This implies that Numerical Cognition and Emotional Freedom reduced Mathematics anxiety among the study participants. The significant differences, made by these two techniques over the control group, accounted for 76.9% variance in the reduction of Mathematics anxiety. The above percentage is the explained variances that could be deduced from these two techniques. The rest percentage i.e 23.1% are unexplained variances that are outside the context of this study. In all, Numerical Cognition and Emotional Freedom were able to account for changes in Mathematics anxiety of the participants.

However, there was a greater mean differences observed in Meridian-based intervention compared to Numerical cognition in the reduction of Mathematics anxiety among the participants. This implies that the intervention was more effective in reducing students' mathematics anxiety level than numerical-cognition intervention. This finding was corroborated by the study of Hopko et al (1999) which found that Numerical Cognition intervention could lead to reduction in Mathematics anxiety. Their study postulated that Mathematics-anxious individuals have a deficient inhibition mechanism, so exposure to numerical cognition training could moderate the anxiety level in the subject.

Mathematics anxiety and numerical cognition across several initial studies, have found substantial evidence for performance differences as a function of Mathematics anxiety. For example, Ashcraft and Faust (1994; also Faust, Ashcraft, & Fleck, 1996) have shown that high-Mathematics-anxiety participants have particular difficulty on two-column addition problems owing largely to the carry operation. When such problems were answered

correctly, the time estimate for the embedded carry operation was nearly three times as long for high-anxiety participants as it was for low-anxiety participants (Faust *et al*., 1996). Thus, high-Mathematics-anxiety participants showed slower, more effortful processing on a procedural aspect of performance, performing the carry operation for suggestive evidence on Mathematics affect and procedural performance in a numerical estimation task, (LeFevre, Greenham, & Waheed, 1993).

On account of significant differences observed on Emotional Freedom intervention and Mathematics Anxiety, the participants showed much lower reduction in Mathematics anxiety than their counterparts in Numerical Cognition group. In line with this finding, Callahan (1985) found that EFT was superior to other CBT therapies used in his study to solve test anxiety problem. He asserted that the tapping provides an external source of energy which, when done correctly, at the right spot, with the mind tuned to the problem being treated, balances the energy in a particular energy system in the body which is suffering from a deficiency or imbalance. A couple of years later Callahan (1992) commented on his practical and theoretical ideas related to tapping. He found that EFT is most significant among the techniques used to solve test anxiety level. He asserted that the points being tapped are related to the ancient meridians of acupuncture. Tapping the proper point when the person is thinking of the problem is quite effective. He then stressed that these points are transducers of energy; where the physical energy of tapping can be transduced into the appropriate (probably electromagnetic) energy of the body so that the person with a problem can be put into proper balance by a knowledgeable person.

This finding was also supported by a similar study conducted by Benor et al (2008) which found a significant causal effect between EFT and other technique in reducing test anxiety. Benor, Ledger, Toussaint and Zaccaro (2008) explored test anxiety benefits of Wholistic Hybrid, Emotional Freedom Techniques (EFT), and Cognitive Behavioural Therapy. Participants including Canadian university students with severe or moderate test anxiety participated. A double-blind, controlled trial was conducted. Their study found no significant differences between the scores for the three treatments. In only two sessions WHEE and EFT achieved the equivalent benefits to those achieved by CBT in five sessions. Participants reported high satisfaction with all treatments. EFT and WHEE students successfully transferred their self-treatment skills to other stressful areas of their lives. WHEE and EFT show promise as effective treatments for test anxiety.

Hypothesis two

Findings on hypothesis two revealed main significant effect of Mathematics efficacy on Mathematics anxiety of secondary school students. It was found (table 1) that Mathematics efficacy had large effect on the Mathematics anxiety posttest score variations, which shows that the differences in the level of mathematics efficacy accounted for 24.3% (Partial Eta Squared=.243) in the variation of the posttest score. This then implies that Mathematics efficacy is very important in moderating anxiety level perceived by students on Mathematics. Self-efficacy refers to people's specific beliefs about their capability to perform certain actions or to bring about intended outcomes in a domain or to otherwise exert control over their lives (Bandura, 1986, 1993; Boekaerts, 1992; Schunk, 1990).When students have high efficacy in Mathematics, their anxiety level would reduce on the subject than when they have low efficacy in the subject. This finding was corroborated by the study of Collins (1984) and Pintrich and Schrauben (1992) which noted that more efficacious students monitored their performance and applied more effort than students who were low in self-efficacy. Similarly, in corroborating this finding, Bandura (1993) asserted that people with high self-efficacy "heighten and sustain their efforts in the face of failure. And also they attribute failure to insufficient effort or deficient knowledge and skills that are acquirable" (p. 144).

Hypothesis three

Findings on the above hypothesis showed that there was significant interactive effect of treatment and mathematics efficacy on Mathematics anxiety of secondary school students. It was revealed (table 1) that treatment and mathematics efficacy had large effect on the mathematics anxiety posttest score variations. This means that Mathematics efficacy significantly moderated the influence of treatment on mathematics anxiety posttest score variances. This indicates that the differences that occur as a result of the interactive effect accounted for 19.5% (Partial Eta Squared=.195) in the variation of the posttest score. In line with this finding, researches have shown that high worry is associated with low cognitive performance (Hembree, 1988, 1990; Pajares & Urdan, 1996; Seipp, 1991). Pintrich and De Groot (1990) found that students with higher self-efficacy, intrinsic value (learning goal orientation), cognitive strategy use, and use of self-regulating strategies (metacognition/effort) had significantly higher grades, better seatwork, and better scores in exams/quizzes and essays/reports.

Implications of the study

The importance of Mathematics on the social, economic, political and educational life of Nigerians cannot be over emphasized with changing time and advancement in science and technology. Mathematics phobia if not curbed and overcome will become more sophisticated and eventually be accepted as a normal way of life among Nigerian students. Therefore, this study demands for an intensive experimental study to find ways on how this phobia could be reduced among the students. Towards this end, counselors and all other helping professionals must be alert and sensitive to effective techniques like those used on this study to help this emotional problem related to Mathematics. The implication of this is that all concerned: teachers, parents, counselling psychologists, school administrators, government etc should embark on intensive studies to identify the different types of Mathematics related problems and find solution to such.

It is also of importance to make a clear distinction between cognitive and emotional distortions resulting in Mathematics failure, which is limiting our students to offer courses related to Mathematics like Statistics in the future. That is why some students in Education and Social Sciences continue to run away from Statistics till today. The factors underlying these behaviours will not be the same in all students, and thus, interventions will be needed towards solving anxiety in Mathematics

The present study has proved that numerical cognition and emotional freedom techniques were very effective in reducing Mathematics anxiety and enhancing Mathematics achievement among the study participants. The study has exposed the participants to how to reduce their false belief in Mathematics disability caused by lack of, inconsistent, poor, or inappropriate systematic Mathematics instruction; inattention, fear, anxiety, or emotion thereby improving their academic self-efficacy to achieve in the subject. It is believed that these two techniques will help the students to have positive thought about Mathematics and learn how to adjust their negative thought and believe in their ability to excel in the subject. Students will know how to plan, control and direct their mental processes toward the achievement of Mathematics in other areas they find themselves. They will understand how to control the time and effort to be used on tasks, and how to create and structure favourable learning environments, such as finding a suitable place to study, and seeking help from teachers and classmates when they have difficulties in the subject.

Conclusion

This study, investigated the effectiveness of two strategic techniques (Numerical Cognition and Emotional Freedom) in reducing Mathematics anxiety and enhancing Mathematics achievement of participants in Ibadan, Oyo State with moderating effect of Mathematics efficacy. Findings of this study has clearly shown that numerical cognition and

emotional freedom have significant effect in reducing anxiety and enhancing achievement in the subject. The two treatments were superior to control group; and emotional freedom technique was superior to numerical cognition in reducing anxiety and enhancing achievement in Mathematics. The results clearly showed that Mathematics efficacy of adolescents moderated the relationship between the two treatments in their effect on anxiety and achievement in Mathematics. It could be averred that low Mathematics efficacy could increase anxiety in the subject and decrease their performance in the subject. Students with higher levels of Mathematics efficacy set higher goals, apply more effort, persist longer in the face of difficulty in the subject and are more likely to cope better.

It was observed from this study that Mathematics anxiety was an emotional, rather than intellectual problem because the problem emanates from inconsistent emotion and therefore interferes with a person's ability to learn Mathematics which later results in an intellectual problem. Therefore, competent functioning in Mathematics requires self-beliefs of efficacy to perform effectively.

Recommendations

Based on the findings of this study, the following recommendations were made:

- The treatment strategies reviewed in this study are recommended for use by educational psychologists, guidance counsellors, teachers and principals of secondary schools.
- The strategies will provide these personnel with requisite educational diagnosis aimed at improving the educational system in Nigeria.
- The study is recommended for policy makers in education to serve as an input on educational issues relating to the improvement of learning.
- The study has revealed that Mathematics is not only an intellectual problem but emanating from emotional problems. Rather than concentrate only on cognitive distortions in the subject, the researchers recommended that other techniques that could resolve emotional crisis in Mathematics should be sought to improve the students' performance in the subject.
- There is the need to re-orientate teachers with contents of the training packages to enable them impart same to their students on a regular basis. This would make students help themselves.
- The training packages can be used by counsellors in schools to give students a new orientation to enhance positive thinking pattern and a new belief in their capability.
- Counselling psychologists and teachers should help students in building their efficacy in Mathematics because Mathematics efficacy has found to moderate the techniques used to solve Mathematics anxiety.

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