Walden University

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Glenroy Pinnock

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2014

Abstract

An Experimental Intervention for Reducing Math Anxiety and Fostering Positive Social Change

by

Glenroy Pinnock

MSc, London University College, 2007

BSc, University of the West Indies, 2002

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

More than 30% of university students with math anxiety taking introductory math failed precalculus in Jamaica. Research has found that lowering math anxiety can lead to better math performance, and the use of binaural beats/isochronic tones has been linked to anxiety reduction. The purpose of this pre and posttest wait-control experiment conducted at a small urban university in Jamaica was to explore the relationship between exposure to isochronic tones and math anxiety. Two groups (n = 21 treatment; n = 27 control) of university introductory precalculus math students displaying differing levels of math anxiety were treated in 18 10-minute sessions with isochronic tones and measured on both math anxiety (Math Anxiety Rating Scales-Short) and math performance (standard mathematics exam). Students' pre and posttest math and math anxiety scores were examined. The correlation between the math pretest and the math anxiety pretest was found to be statistically significant. In addition, the mean math posttest score differences between Groups 1 and 2 were statistically significant, favoring the treatment group. Last, for posttest math anxiety, the mean differences between Groups 1 and 2 were statistically significant, favoring the treatment group with lower math anxiety. The project and recommendations involved examining other ways of reducing math anxiety in addition to isochronic tones and suggestions for the examination of other interventions to improve students' mathematical outcomes in education. The implications for positive social change include informing local teachers, parents, policy makers, and students about the problem of math anxiety and possible treatments to reduce it. As a result, it is hoped that students' math anxiety will be reduced and greater math achievement realized.

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Dedication

My study is dedicated to my mother (Norma), and sister (Pasty). I know you guys are fully aware of the purpose of this research, because both of you listened to numerous discussions of different sections from proposal to final draft. Just want to say thanks for listening to me even when you were not sure about my scholarly delineations.

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Section 1: The Problem

Introduction

Recently, Jamaican students showed a high math failure rate. According to Coquhounl and Bourne (2012), in 2005, only 62% of the students who sat the fourth grade literacy and numeracy standardized examination performed satisfactorily. In addition, they posited that less than 40% of local students failed the Caribbean Examination Council (CXC) math test between the years 2000 and 2009. Although this article referred to a problem in literacy and numeracy, my position is to shed light on the numeracy/mathematical component in adult education at the tertiary level. Currently, the Jamaican educational system levels are kindergarten, primary, high school, and the tertiary levels. These four levels are the different stages of the Caribbean regional education system. This educational system is partially sponsored by the government of Jamaica. To address this problem, a program in literacy and numeracy was implemented at 72 poor performing government schools, from 1998 to 2005 (Lockheed, Harris, & Jayasundera, 2010).

Definition of the Problem

The math crisis in Jamaica has become quite evident at the university level. At a small urban university the introductory math courses (i.e., college algebra and precalculus) have shown a high math failure rate. According to a recent report from the head of the math department at the university, 74.9% of students passed precalculus/college algebra; 712 out of 951 students achieved 50% or more (i.e., the passing grade) in their final semester precalculus math examination. Undoubtedly, this

pass rate must be improved to at least 90%, so that more students can pursue courses in engineering and business studies. In trying to understand why so many students were failing (i.e., approximately 25%) precalculus math, in trying to understand this scenario, I learned that the students were experiencing problems with math. Many of these students cited the following: (a) a fear of the subject developing as early as fourth form in high school of the Caribbean system; (b) a loss of memory while taking exams; (c) sweaty hands during exams; and (d) extreme nervousness when attempting to answer test questions. Noting the similar experiences of many Jamaican students who are weak in math, I was pushed to do preliminary research on the feelings they mentioned. Subsequently, I hypothesized that the math students were experiencing math anxiety.

Math anxiety is a disorder that affects memory and the ability to think clearly; it is a serious problem affecting students' cognitive abilities and is normally reflected in math *students receiving low test/exam scores (Ashcraft & Krause, 2007). This form of anxiety* affects students in the local university. Although my observation of the students' problems could be classified as symptoms of math anxiety, there was no local data collection on math anxiety. This meant that there was an existing knowledge gap on this topic locally, but the high failure rates mentioned above needed to be addressed. In Jamaica there is no regulatory body that monitors nonclinical intervention programs for math anxiety. So, any qualified person lecturing at the university level should be competent to administer a nonclinical treatment for an educational research project.

Rationale

Evidence of the Problem at the Local Level

At a small urban university the pass rate of 74.9%, and 40% at the secondary level, reflected Jamaicans' dismal numeracy competency. Some likely influencing factors for this poor performance at the university level may be math anxiety, crime, violence, and economic depression. These low results could account for Jamaica's low gross domestic product (GDP), which was in the single digits at the time of this study. The 2014/15 budget targeted an ambitious 7.5 percent of GDP primary surplus, because in former years the GDP was at most 4.3 percent (Country Report, 2014).

Because of economical depression, there exists the need for reforming mathematics education. Although this change is needed, the prevalence of mathematics anxiety continues to persist locally. Despite the gap in the practice of intervention programs to correct or minimize math anxiety locally, practitioners have been conducting many studies internationally. Locally, the topic of math anxiety was under discussion by faculty and staff members at regular departmental meetings. Also, the university lecturers were very concerned about mathematical incompetency of students, which extended into other educational disciplines. According to Furner and Gonzalez-Dehass (2011), many students tend to be affected by math anxiety; as a result, they freeze up and cringe when they are to do any form of computational exercise. In addition, there are some others who dread taking math classes at the college level. According to Boyne (2011), the World Bank identified other disincentives to growth, such as poor quality of education and poor fiscal policies and budget management practices over four decades. In addition, he stated

that in Jamaica for the last 20 years, the real per capita GDP has increased on average only 1%.

According to Douglas (2010), all the improving countries have one thing in common, and that is a good mathematics educational policy. For this reason, the Minister of Education Andrew Holness has called for more scientific research in the field of mathematics education. Scientific research indicated that the researcher should conform to standardized guidelines during his or her studies (i.e., researchers should use either scientific quantitative or qualitative enquiry to investigate educational problems). According to Walker and Wachs (2007), developing countries need intervention programs to stimulate cognitive development because of the prevalence of risk factors in these countries. In addition, they asserted that intervention programs can minimize the number of students failing math.

Evidence of the Problem from the Professional Literature

According to Alloway, Gathercole, and Kirkwood (2009), the majority of the children struggled in the learning measures and verbal ability. This research project was sponsored by the economic and social research council of Great Britain. Likewise, Lyons and Bielock (2012) confirmed that high levels of anxiety affect persons by causing tension, apprehension, and fear. Akin and Kurbanoglu (2011) posited that math anxiety is negatively correlated to math attitude and self-efficacy. According to Witt (2012), the presence of digits causing lower working memory performance was associated with math anxiety. Although math anxiety primarily impacts students pursuing math courses, Leppavirta (2011) argued that math anxiety can impact engineering students' academic

performances negatively; hence far more research should be done in this discipline to substantiate this research finding . Additionally, Khatoon and Mahmood (2010) revealed that math anxiety was related to independent variables (i.e., gender, school types, and math achievement of the secondary school students).Gender and school types are touted to be significant contributors to cause math anxiety.

Chapman (2010) posited that in other educational disciplines, particularly geography, educators teach mathematics as a service subject. In this case, Chapman observed that there was a fear (i.e., math anxiety) for participants who had not studied beyond General Certificate of Secondary Education (GCSE). Although there are changes being made to math curriculum in England, math anxiety still persists amongst students. In fact, math anxiety is infrequently treated (Chinn, 2008). According to Legg and Locker (2009), at low meta-cognition levels, performance is inversely proportion to anxiety. According to Ertekin, Dilmac, and Yazici (2009), the correlation coefficients between pre-service math anxiety levels and learning styles are significantly related. So from the aforementioned cases, math anxiety is very prevalent among a wide range of persons.

The purpose of this study was to conduct a secondary analysis of data from an investigation conducted by the local university of whether math anxiety can be treated through an intervention program of isochronic tones, thereby decreasing mathematics anxiety and hence improving precalculus math test scores.

Definitions

Beats: This is the phenomenon that occurs if two sources of sound waves are at close frequency but not exactly the same (Giancoli, 1991).

Binaural beats: The dicholic presentation of two sinusoids with a small frequency difference produces a perceptual fluctuation. For example, the listener perceived a fused image around 105 Hz that beats at 10 per second when a 100 Hz tone is presented to one ear and 110 Hz is presented to the other. Binaural beats are closely spaced tones up to about 1000 Hz (Karino, at al., 2006).

Brainwave entertainment: Brainwave entrainment occurs when the brainwave frequency duplicates that of the external stimulus, whether it is audio, visual, or tactile. The effect can be seen on EEG equipment (Siever, 2003).

Event-related brain potentials (ERPs): An event-related potential (ERP) is the ability to measure response of the brain through direct sensory, cognitive, or motor event (Luck, 2005).

Isochronic tones: These are regular beats of a single tone used for brainwave entrainment. In this case, the listener can listen the beats without a headphone (Siever, 2003).

Monaural beats: Monaural beats are derived from the convergent of two frequencies within a single receiver (Siever, 2003).

Principle of superposition: When two sound waves are moving opposite or in the same direction to each other, the resultant wave undergoes destructive or constructive interference. Note that the resultant amplitude is greater than the amplitude of either wave (Giancoli, 1991).

Significance

The findings from the study will be sent to the stakeholders (i.e., the minister of education, dean of faculty, and lecturers). Particularly, the minister of education has recently enforced a policy in parliament to implement a national educational television program. One of the goals of this program is to improve education in Jamaica's high school system through information communications technologies (The e-Learning Jamaica Project, 2013). Therefore, this medium could be used to inform students and parents about how to treat math anxiety once it is identified. In addition, this project study might be able to impact positively some global mathematical concerns relating to math anxiety. This equipment to treat math anxiety is relatively inexpensive and requires a small physical space for it to be set up. As such, many schools may be able to replicate this type of experimental research over a wide range of students in different settings. In fact, it is unlikely that integrating the intervention research will disturb regular face-to-face classroom settings. Students and participants may have found it extremely difficult to find extra time to be involved in research outside of typical classroom times.

Guiding/Research Question

The research question guiding this study was the following: What is the relationship between the mean precalculus test scores (dependent variable) of university students with different levels of math anxiety measured from the Mathematics Anxiety Rating Scale-Short (MARS-S) questionnaire and isochronic tones (independent variable)? In this study, I tested two hypotheses: (a) Math anxiety (independent variable) is negatively correlated to students' math pretest scores (dependent variable), and (b)

isochronic tones (independent variable) will impact positively students' posttest for math anxiety and mean precalculus test scores (dependent variable).

Review of the Literature

In order to address the aforementioned local problem, that is, widespread math anxiety, it was imperative to critique and synthesize previous and current literature relating to math anxiety and performance improvement. The literature was accessed by searching online database from Google Scholar, Google, and Walden Library for current peer-reviewed journal articles. The searching process was done by Boolean searching method (i.e., NOT, AND, OR selections). For this review, four components will be discussed in the following order: (a) theoretical frameworks; (b) math anxiety; (c) binaural beats, monaural beats, and isochronic tones (these tones with deeper amplitudes that can stimulate brainwaves to enhance learning); and (d) research on music use to enhance learning. In addition, there are other possibilities why some students cannot perform satisfactorily on their math tests. Some of these areas are (a) lacking familiarity with the test; (b) test anxiety; (c) lacking study skills; and (d) lacking proper instruction in math. Despite the many existing possibilities, I will be addressing only one (i.e., math anxiety).

Theoretical Frameworks

First, a theory explains how sequential occurrences of a particular situation in the real world occur. Second, hypotheses can be used to predict the possible outcomes of a scientific study inquiry, that is, directional or nondirectional.The theoretical frameworks underpinning the intervention program central to this project study included beat

frequency in the superposition of wave theory (i.e., in the subject physics; Aguilar, Robledo-Sanchez, Carrasco, & Mendez Otero, 2012); for superposition of two waves, as in the case of isochronic tones, the resultant wave will now oscillate at a frequency of one half the sum of the respective frequencies. In addition, the resultant wave intensity will be increasing and decreasing with frequency called the beat frequency (i.e., the difference of the frequencies between the two waves; Aguilar et al., 2012).

The theoretical frameworks also included holonomic brain theory, the beat frequency phenomenon, which is the difference of two frequencies that are numerically close (Giancoli, 1991). The optimum frequency range for cognitive development is 15 to 18 Hz (Othmer& Kaiser, 1995). Holonomic brain theory provides the understanding of how this music/sound stimulates neurons in the brain. Various audible frequency ranges can stimulate delta, theta alpha, beta, and gamma brain waves. Additionally, it is believed by researchers that the pulsating light stimulus can stimulate beta waves at a frequency of about 16 Hz. Goodinet al. (2012) claimed these waves were an indicator for cognitive abilities and mathematical reasoning in human beings. Despite the two different methods of brainwave stimulations mentioned above, in this study, I primarily focused on music or beats stimulation. These theories posited that humans can tap into the reservoir of high potential that alpha and beta waves represent. In essence, rhythmic beats may help the development of cognitive thinking skills (Pribram, 2007).

Superposition of Two Sound Waves

For two-dimensional waves traveling in the same or opposite direction, whenever they collide they form a resultant wave with an increased amplitude. Something similar

happens if two sound waves are directed to enter the left and right ears through the participant's headphone. The individual's cerebella cortex will later perceive these sound waves as beats during synchronization (Brattico, Bogert, & Jacobsen, 2013). Prior to the beats formulation, the displaced sound waves are expressed as sine functions (y_1) and (y_2) respectively. From superposition principle, the resultant sound wave is the mathematical summation, that is, $(y_1) + (y_2)$. This resulting sound wave is now expressed as a function in x and t:

$$y(x,t) = y_m \sin(kx - \omega t) + y_m \sin(kx - \omega t + \phi)$$
$$= 2y_m \cos\left(\frac{\phi}{2}\right) \sin\left(kx - \omega t + \frac{\phi}{2}\right)$$

In this scenario, Φ is considered to be zero for the phase modulation and the angularly frequency is constant. However, in a case where the frequencies are numerically close, the resultant wave is deduced similarly from the sum of two sine functions (Aguilar et al., 2011). Finally, the principle of superposition can be viewed through the windows of constructive or destructive interference; that is, the resultant sound wave has a nonzero or a zero displacement function expressed in terms of y and t.

Brain Waves and Musical Wave Forms

Lu et al. (2012) asserted that two forms of electroencephalograhic EEG brain wave recordings can be converted to music. This musical form will constitute both pitch and intensity of the of the brain music A brain music system is one that can generate musical outputs. These wave forms are collected by placing electro-probes at specific points on the human's scalp, which are then converted to music (Trevisan & Jones, 2008). According to Wu, Li and Yao (2009), training humans to be able to professionally

identify free-scale brain music would make it easier for them to be able to diagnose certain stress-related diseases. For example, I argued that a person who is in an anxious state could become relaxed if he or she listened to their own brain music. The ability to process music requires intriguing perception and cognitive abilities associated to memory and emotion (Andrade & Bhattacharya, 2012). Although theorists have concurred that in general instruction consists primarily of brain-based and hands-on activities, classroom learning activities require cognitive and motor skills (Wilmes et al., 2008). In fact, developing cognitive abilities through therapeutics (i.e., biofeedback) has been around long time.

Generally, cognitive thinking skills (i.e., reasoning and memory) are necessary for good mathematical abilities to be developed, which will cause fewer students to fail mathematics. In this case, memory is a function of the brain activities. Hopefully, through brain waves entrainment the optimum brainwave stimulation can be acquired, which will impact students' mathematical competencies positively.

Brain Activity and Memory

Since the early 1970s, neuroscientists became aware that patients could alter their brain wave activity (Cleary, 2011). Myers and Young (2011) showed that biofeedback helps persons to self-regulate their brain activity. According to Bauch and Otten (2011), in the process of learning, electrical brain activity is tested by an EEG, which revealed memory improved when the retrieval process overlapped or repeated. Event-related brain potentials (ERPs) experimental measures revealed that persons with autism spectrum disorder (ASD) can be trained to become experts at recognising faces (Faja et al., 2011).

According to Liu, Shi, Zhao, and Yang (2008), low-frequency (delta: 0.5-4 Hz; theta: 4-8 Hz) showed that 18 intelligent students' brain activity, that is, ERPs, was significantly higher than students of average intelligence. Steinhauer, White, and Drury (2008) have shown that ERP research in brain activity can provide greater understanding of second language acquisition (SLA) in adult students.

In neuroscience Wong and Gauthier (2009) depicted that brain activity is correlated to behavioural measures of experts reading musical notation. Similarly, Marcedonia, Muller, and Friedderici (2010) argued that the pillars of neural science being associated with students' high performance was demonstrated in a learning activity in which participants learned 92 words in a training task. The authors asserted that the brain activity measured at the time of word recognition was related to behavioural collected data. Nonlinear association of brain activity and behavioural function of developing adolescents during cognitive tasks is significant (Dumonthiel, Houlton, Christoff, & Blakemore, 2010).

Collins et al. (2010) stated that the learning of new skills requires the change in the harmonic synergy between the neuron networks in the brain. This change results in the decrease or increase of brainwave oscillations of delta and theta waves. Collins et al. observed two learning tasks, which included a figure and worded associations. The results of the EEG displays revealed greater coherency of brain activity for the participants doing the figure association task. Currently, new methods of eye tackling and measures of brain activity have been providing clarity, explanations, and findings for conventional works (Bremner, 2011). According to Ikkai, Jerde, and Curtis (2011), the

theory of cortex brain activity (i.e., response time) is positively correlated to the increase in demands on perception.

Also, Cho, Ryali, Geary, and Menon (2011) posited that cognitive development and learning is more related to continuous use memory-based problem solving rather than effort-related activities. Additionally, there are some neurons that can perform multiple specific functional tasks that enhance memory (Padovani, Koenig, Brandeis, & Perrig, 2011). In correlation and regression analyses used to examine the relationship between brain activities of two hemispheres in old age persons, Angel, Fay, Bouazzaoui, and Isingrini (2011) found that activity was related to accuracy of memory performance. However, motor-related activity was detected in the cerebellum; smooth activity is unable to be detected by cortical control responses (Burke & Barnes, 2011). This means that the overlapping of neuron vibrations during brain activity is interpreted in the cortex region.

Math Anxiety

Math anxiety was first recognized in the United States in the early 1970s (Richardson & Suinn, 1972), and the first math anxiety rating scale (MARS) was developed by researchers Richardson and Suinn. According to Suinn and Winston (2003), a 30-item validated instrument is a time-efficient measuring tool for levels of math anxiety. Math anxiety is a disorder that affects memory and the ability to think clearly; it is a serious problem affecting students' cognitive abilities, and is normally reflected in math students receiving low test/exam math scores (Ashcraft & Krause, 2007). According to Isiksal, Curran, Koc, and Askun (2009), there exists a negative correlation between math anxiety and students' mathematical self-concept.

According to Beilock (2008), when pressure is on the functionality of working memory tends to decline, hence a stressful situation arises, as in the case of mathematical anxious students.

Likewise, Ramirez and Beilock (2011) stated that students who normally choke are likely to perform below their level of competency, as in the case of mathematical anxious students. Math anxiety has been confirmed in both bilingual and monolingual students. As mentioned in the article (The Mathematics Anxiety of Bilingual Community College Students, 2009), in a sample of 618 (i.e., 361 monolingual and 257 bilingual) participants in a community college, it was revealed that 20.6% and 20.7% were mathematical anxious. This was confirmed from a survey conducted with the Abbreviated Math Anxiety Survey (AMAS). Furthermore, it was confirmed that although the girls were receiving lower math anxiety scores they were less mathematically confident than boys. The relationship between math anxiety, attitude toward math, and mathematics success has been delineated (Yenilmez, Girginer, & Unuz, 2007). According to Fernandez-Castillo and Gutierrez-Rojas (2009), the variables anxiety, depression and academic performance are associated. Specifically, anxiety and depression are positively correlated, while depression and academic performance are inversely correlated.

In general, the instruments used for measuring variables or other surveying purposes must be checked for validity and reliability. Standardized tools should be used with reasonable evidence for validity and reliability when available (Yuskel, 2008). A review of instruments to measure math anxiety was undertaken, and available evidence for the validity and reliability of instruments compared to standardized values of

RMARS, MAS and MARS (Balog˘lu & Zelhart, 2007). Additionally, According to Vahedi, Farrokhi, and Bevrani (2011), statistics anxiety measure (SAM) provides valid measure for college students with anxiety issues.

Of the five instruments reviewed, MARS-S is the norm for U.S. adults/college students, MARS-A is the adolescent version for junior/senior high (7th-12th grade), MARS-E is for elementary school (4th-6th), and STABS is the Suinn Test Anxiety Behavioral Scale. MARS-S (The Mathematics Anxiety Rating Scale Rating, a brief version: psychometric data, 2003) was the most widely used in adult education with acceptable validity and reliability statistics (Suinn & Winston, 2003): the Cronbach alpha of .96 indicated high internal consistency, while the test-retest reliability for the MARS 30-item was .90 ($p < .001$). The validity on a college sample, correlations between the MARS-S and the longer MARS were found to be r =-.92 ($p < .001$) for the original testing and -.94 ($p < .001$) when both tests were re-administered one week later. Hence the MARS-S appears to be equivalent to the MARS.

In terms of content validity, factor analysis of the MARS scores indicated the presence of two primary factors, the first accounting for 59.2% of the variance and the second 11.1%. This is consistent with other studies identifying two major factors for the longer MARS. There were22 test items showing loading on either of these two primary factors (Suinn & Winston, 2003).Additionally, Alexander (2012) developed the abbreviated math anxiety rating scale (A-MARS), which is a 22-item questionnaire constructed from Suinn's MARS-S version.

Beats, Monaural Beats, and Isochronic Tones

Two vibrations of two slightly varied frequencies constitute what is called the beat phenomenon. In this case, the summation of the vibrations is considered, each of which is expressed in terms of the sine or cosine function (Lim, Kyung, & Kwon, 2012). The authors further explained that the vibration can interpreted as a stimulus. For example, if two pin heads are continuously impacting the two finger tips of a person then an individual will perceive the beat phenomenon. Similarly, binaural beats, which were defined earlier in the paper, are an auditory phenomenon being triggered as a result of brainwave entrainment, which is used to alter physiological process and cognitive skills (Goodin, Baker, Carey, & Harper, 2012). According to Cameron, Stewart, Pearce, Grube, and Muggleton (2012), listening to music is an auditory process and the human can synchronize its body movements with the perceived beat. Likewise, the areas of the brain connected to motor function are also associated to the perceived beat and rhythm. According to Lavallee, Koren, and Persinger (2011), binaural beat frequency of 7 Hz facilitates meditation, whilst binaural frequency of 15 Hz is used to enhance reasoning and problem skills,

Monaural beats can be used to stimulate electrical activity of the neurons through frequency response process (Oster, 1973). This process is called brainwave entrainment. Recently, brainwaves entrainment engineer Morry Zelcovitch introduced (The Morry Method). In this entrainment process, Zelcovitch uses isochronic tones (i.e., waves with deep amplitudes to create frequency responses). Generally, music is used as an intervention for anxiety. But recent research has shown that specifically designed

rhythmic patterns, tone textures, chord progressions, and harmonic resonances can help reduce anxiety (Akombo, 2006). The beat phenomenon is the interference of two beats with slightly different frequencies superimposed on each other. Monaural beats are absorbed by both hemispheres of the brain through headphones and these beats can trigger brain waves (Pribram, 2007).

Isochronic tone is the most useful and effective form of brainwave entrainment. In fact, it is stated that the waves of this tone have deeper amplitudes, therefore producing greater resonating response of brainwaves (Oster, 1973). According to McAuley and Miller (2005), isochronous tones are sequential in time interval of the beats; hence a greater degree of brain stimulation can be attained by the entrainment process. "Inferential statistics found that the relaxation training regimen of high achieving eighth grade students' led to significant decrease in test anxiety" (Kacprowicz, 2008, p. 4).However, the relaxation sessions did not impact students' test performance. That is, two instruments, based on self-report, the Friedben Test Anxiety (FTA) and the Rosenberg self-Esteem Scale (SES) measured the outcome variables of test anxiety and self-esteem.

Anxiety also affects service teachers, who often use therapeutic treatment to minimize its effects (Daly & Morton, 2011). With math anxiety being a form of anxiety, therapeutic treatments in the form of audio-video entrainment (AVE), which is audio-video cortex stimulation, can be applied to math anxiety students (Siever, 2003). In this case, I will be focused on isochronic tones. According to Morse and Chow (1993), a study involved three groups of participants, which demonstrated a control and two

experimental groups. From the Morse and Chow study, it was shown that the experimental group receiving AVE treatment plus alpha beats had a reduction of their anxiety levels. Additionally, isochronic tones/monaural beats and binaural beats are used to treat anxiety associating with fear and nervousness. Oster (1973) used an EEG oscilloscope to demonstrate that binaural beats can only stimulate very small evoked electric potentials within the auditory cortex of the brain. In fact, this will cause minimal audio entrainment.

Ulam (2006) used an experimental study to explain the impact of binaural effects on brainwave entrainment. In this case, a three-factor, mixed ANOVA has shown no significant differences between the treatment and control groups. Particularly, binaural beat stimulation caused no greater incentive for theta waves than the control conditions. Additionally, theta (ie., at a low frequency range at approximately 6 Hz) was no more behavioral variation during binaural beat stimulation of the two groups. However, Le Scouarnecet.al (2001) administered binaural beats tapes (i.e., A, B and C) to patients for listening and revealed a significant reduction in the anxiety score reported daily in patients' diaries. In this study, the participants ranged between10 to 17 and they listened for 4 weeks, at (an average of 1.4 to 2.4 times per week) for approximately 30 minutes per session.

Finally, a study of the participants' revealed that tape B (i.e., the purer form of binaural beats provided results similar to isochronic or monaural tones) was preferred, because of its clarity and extended patterns of binaural beats, over tapes A and C. There has been a difference in the pre-and post-test listening State Trait Anxiety Inventory

scores, which revealed a decrease of anxiety. Despite an existing difference in the test scores, this difference was not statistically significant. In order to hear monaural beats, both tones must be of the same amplitude. However, binaural beats are audible when the sound waves are of varying amplitudes. So, this process is defying the superposition principle in physics. These beats can even be heard if one of the tones is below the hearing threshold. Noise reduces the perceived volume of monaural beats whereas noise actually increases the loudness of binaural beats (Oster, 1973).

When a person hears fewer than three binaural beats a second, the beats appear to move sinusoidal (i.e., with a negative and a positive amplitude) across the head. This apparent motion is a result of the way the brain processes sounds. For frequencies that are low and, numerically close (i.e., the number to cycles per second), the brain determines the beat of the sounds by detecting the difference in the frequencies of the two sound waves. However, for sound waves of higher frequencies the brain cannot process phase relationship at these high frequencies and therefore detects the differences in amplitudes of sounds striking the ear simultaneously. For this reason, monaural beats are considered to be more suited for therapeutic treatment. In this case, monaural beats/tones are audible at any pitch whereas binaural beats are best perceived at lower pitches, for example, at approximately 440 Hz.On the other hand, binaural beats using above 900 Hz are typically not detected (Oster, 1973). Isochronic tones versus the monaural tone concept is demonstrated by filtering the excessive noise from binaural beats at a frequency of 1000 Hz; when these signals were directed to the left and right ears, the left hemisphere showed greater robust attention (Stracke, Okamoto, & Pantev, 2009). This depicts that

isochronic tones and monaural tones provide greater brain stimulation than binaural beats. In fact, these waves/tones are purer forms of binaural beats, vibrating at higher frequency levels.

Generally, listening to music is an emotional and educational experience, which shape a person's values and action (Levy & Byrd, 2011). However, the music listened by infants from television programs can interfere with their learning abilities, that is, when the auditory context is altered (Barr, Shuck, Salerno, Atkinson, & Linebarger, 2010). According to Keskin (2011), music and melody can impact positively in the reduction of stress and anxiety. Mahdipour and Nematollahi (2012) conducted a quasi-experimental, pretest-posttest design to 150 participants, which was further divided in an experiment (i.e., participants being treated by listening to music) and a control group. The participants were tested with the depression, anxiety stress scale (DASS 21). It was shown from the posttest treatment group that the mean score of anxiety was reduced to one half of the initial pretested mean score,

Specifically, anxiety can be treated through therapeutic treatments. Particularly, it can be treated through simulating beats (Huang & Charyton, 2008). This treatment is called brain wave entrainment (BWE), which helps in cognitive development. By definition, entrainment occurs when the brain wave frequency duplicates that of the stimuli, whether audio, visual or tactile (Siever, 2003) as can be seen on an EEG.

Huang and Charyton (2008) have shown that BWE is an effective therapeutic tool that can help people who suffer from cognitive functioning deficits, pain, and stress. However there are instances when the researchers recommended that more research

needed to done. Most social science students' who suffer statistics anxiety are those who develop a negative attitude as result of their teachers' perceptions; that is, students become tired of negative comments made by their instructors (DeCesare, 2007). According to Draznin (2008), more long-term studies are needed on the prevalence of math anxiety of introductory University students before any real effective implementation of interventions for their reductions are administered. Mckoy (2006) suggested that educators must be careful not to select instructions or intervention programs on the basis of popular administration by researchers.

There are different levels of anxiety for different subjects, but research has shown that math anxiety is correlated positively to science anxiety because numeracy is involved in these subjects. In contrast, public speaking anxiety and presentation anxiety have a low correlation coefficient (Storts, 2007). Mathur (2009) argued that students' cognitive-behavioral anxiety was very high prior to the intervention program, compared to low students' anxiety after the intervention program was administered. Olatunde (2009) revealed that there is a relationship between math anxiety and students' academic achievement. That is, math anxiety impacted students' academic achievement negatively. Hence, new teaching alternatives to reduce math anxiety might cause more adults to pursue further studies in math and/or science, if those alternatives are shown to be effective.

Music/Beats as an Aid to Learning

Some scholars hold that music can stimulate learning. In fact, music is a combination of beats/tones, which has been discussed above. According to Merriam

(2006), some traditional forms of learning need to be reshaped. She asserted that educators in both adult and non-adult institutions should be looking at a more student-centered learning approach rather than a teacher-centered method. One way to do this is through a somatic way of learning, for example, which is a spiritual form of learning through music and poetry. In addition, According to Church, Mercado III, Wisniewski, and Liu (2012), training can improve perceptual sensitivity, that is, there is a relationship between stimulus and responses. Rhythmic abilities vary widely in the general population, because of auditory and motor areas that are involved in the process (Grahn & Schuit, 2012).

In addition, Bishop, Amankwatia, and Cates (2007) are of the view that sound may hold great promised for instructional software by supporting learning in a variety of ways. Music education may effectively contribute to young children's awakening to reading and writing, whether or not learning difficulties are an issue (Bolduc, 2008). For many years theorists have been advocating for the use of arts in learning. In fact, they argue that arts are integral for the education of the whole child (Catterall, 1998; Eisner, 1998; Gardner, 1999a, as cited in Gullatt, 2008). According to Rauscher and Shaw (1997, as cited in Harris, 2008), a connection linking music lessons to improved spatial-temporal reasoning abilities in 4- to 6-year-olds has been demonstrated. While musical intelligence is viewed as a separate intelligence, there is a high correlation between math and music (Yoon, 2000, as cited in Harris, 2008). In 1993, a study was done at the University of California, Irvine that showed a temporary improvement of IQ scores when students listened to 10 minutes of a Mozart sonata. The specific area of increased intelligence was

spatial-temporal reasoning. This effect has since been dubbed the Mozart effect and has encouraged both further study and other views (Jones, 2002). Particularly, in the United States, it has proven controversial.

However, studies at the M.I.N.D. Institute have shown dramatic math and cognitive enhancements as a result of simultaneous musical instruction. Students enrolled in this program received approximately 20% higher scores than students who were not in the program. In fact, the students' scores continued to increase the longer they spent in the program (M.I.N.D. Institute, 2004). Also, online courses are usually presented with music at the start, before the presenter starts speaking. Recently, e-learning has become very popular, and most online podcasts and videos are highlighted with instrumental music. According to Thomas and Amit (2007), these learning-style instruments do enhance student learning.

Specifically, cognition is imperative to determine students' performances in exams (Huang & Charyton, 2008). Carter and Russell (1993, cited in Huang and Charyton, 2008) used a pre- and posttest design to show significant improvement for students who were performing poorly. Lane (1998, cited in Huang & Charyton, 2008) compared two experiments (i.e., E1 and E2) of simple tones (16 Hz to 24 Hz) through headphones to show positive outcomes. Olmstead (2005, cited in Huang & Charyton, 2008) demonstrated students' improvement in the WISC-111 arithmetic by using an experimental research study. All in all, while research results are promising, there is still a need for much more research in this area. According to Moreno et al. (2011), it was proven that two interactive computerized training programs (i.e., visual arts and music)

administered to preschool children enabled them to improve their verbal performance after twenty days of training. According to Kimble and Protivnak (2010), music intervention can be used by schools' counselors to correct behavioral problems of adolescents in the classroom. Although it has been said that music interventions can help students to develop social, behavioral, and communicative skills (i.e., autism), there is still more research to be done (Simpson & Keen, 2011). Participants in an experimental research pretest and posttest design study showed significant improvement in self-esteem scores in a mentorship program (Darrow, Novak, & Swedberg, 2009).

Arguably, music, movement and math have been closely related from ancient times until today. This notion was demonstrated in an experimental research by Tsapatori, Pollatou , Gerodimos, and Mavromatis (2009). The researchers had selected 110 first grade students, from which 55 were placed in an experimental group (i.e., treated with music-movement intervention) and 55 in a control group. The students were examined by using the same math test. It was revealed that the students in the experimental group performed significantly better (i.e., p-value less than 0.05) in the test. In the case of educational settings this form of treatment is less expensive. According to De Niet, Tiemens, Lendemeijer, and Hutschemaekers (2009), Music-assisted intervention can be used without intensive investment in equipment and training, therefore less expensive to conduct.

According to Courey, Balough, Siker, and Paik (2012), music intervention program helped 33 third grade students from a northern California to perform better at computational fractions than those students who were taught by strictly regular math

instruction methods. However, the music intervention program did not help the students to understand the concepts of fractions. According to Standley (2008), music intervention affect children's reading skills in a strongly moderate and significant manner, therefore, effect sizes were shown to be 0.44 and 0.66.Although these values seem to be high for educational research, Kostenius and Ohrling (2009) posited that children whose lives demonstrated stressful situations can actually be corrected, if they are relaxed. Later on in life these children will be less stressful. According to Taylor and Rowe (2012), the Mozart Effect (i.e., a CD of background music being played while students did major trigonometry test) impacted positively a sample of 69 trigonometry students in six major trigonometry math tests. The scores for these students were proven to be significantly higher than a sample of 59 trigonometry students who had no background "Mozart Effect" during their tests.

Winsler, Ducenne, and Koury (2011) provided explanation for the association between behavioral self-regulation and children's experiences being developed during program called Kindermusik. According to Darrow, Novak, Swedberg, Harton, and Rice (2009), findings for the dependent variables indicated participants' self-esteem scores in the music intervention mentorship groups from pre-to posttest, which was more than the control group, although not significantly. Shafi (2010) asserted that various methods of poetry therapy can be used to satisfactorily treat schizophrenic symptoms. Kostenius and Ohrling (2009) posited that children's lived experiences of being stressed can cope and ultimately transformed, if they are relaxed, this transformation can enable these children to become powerful.

Test-Wiseness Skills

Todd and Ping (1996) have shown for a model of test-wiseness test taking behavior revealed that there is a need for relevant partial knowledge in the application of test-wiseness. Therefore, educators should be aware that test-wiseness skills will help to improve their overall performance. It is imperative to provide alternative explanations of some other possible reasons (i.e., other than math anxiety) why students receive low math test scores. Some of these reasons could be as follows: (a) students don't know the learning material; (b) students don't know how to study; (c) students lacking test taking strategies; (d) students were poorly instructed. Test wiseness skills/test strategy was first introduced by (Thorndike, 1951). Students can be trained to do well in high-stakes test; indeed, this process extends long before the day of the test (Doe & Fox, 2011). Cohen (2006) declared test taking strategies has come of age over the past 25 years; however there is still no unified theory that has been establish. Also, Kettler, Braden, and Beddow (2011) explored the interaction between instructions of test taking skills and recently embraced the access computer-based tests. Coaching and pretest effects were examined in two German Hauptschule and Gymnasium schools. Results showed that only a combination of coaching and pretesting setting impacted students' performances positively (Brunner, Artelt, Krauss, & Baumert, 2007).

Dosch (2012) revealed that students who were tested by using computer-based testing scores received higher than students who used pencil and paper method. He stated that this is due to the practice the students went through while using the computers. Appel, Kronberger and Aronson (2011) stated that stereotype behavior affects female

students of science, technology engineering and math (STEM) in such a way that their performances are affected in exams; also their behavior for development is impacted negatively. According to Powell (2012), math test accommodation is an effective way of assisting students with math phobia. In this case, both multiple choice and objective type questions were read out aloud for students with disability. Indeed, this is a very good example of considering students' needs to foster learning.

Edwards and Rottman (2008) demonstrated that a convenience sample examinees IQ levels were impacted by the lived experiences of graduates' examiners. These graduates revealed higher IQ levels when they were tested repeatedly. Unfortunately, for examiners lacking necessary experience might impact students' performances. Bag`es and Martinot (2011), same-gender role model can impact fifth graders math test performance, because the stereotype problem could be impacted positively. According to Hollis-Sawyer (2011), stereotype threats affect nontraditional aging math students more than high school students. According to Weimo Zhu et al. (2011), new testing theories (e.g., item response theory, test equating, and item bank) have many advantages over previous theories, because the standardized nature, which are considered to be more valid and reliable measuring tools than those based on classical true score theory. According to Tseng and Wang (2011), guiding imagery techniques help to aid students in overcoming test anxiety. Some of the techniques include relaxation training and positive self-talk.

Researchers, Krebs, and Roebers (2010) demonstrated that, memory retrieval is pertinent for subsequent metacognitive processes. For a sample of 107 participants, all children were able to control their test-taking behavior to the benefit of test accuracy by

withdrawing incorrect answers. According to Heijne-Penninga, Kuks, Hofman, and Cohen-Schotanus (2010), in the context of test taking ability, 'mastering' means being able to recall and apply knowledge to a given discipline. The researchers argued that mastering can be achieved from both closed-book and open-book test. However, open-book test is not a typical form of evaluation in our educational system. Finally, Dodeen (2008) argued that test-taking strategies are pertinent cognitive skills, which can impact students' tests scores. Furthermore, improving students' test taking skills will reduce test anxiety.

Study Skills

Apart from math anxiety, perhaps there are other possible causes for math students receiving low test scores. For example, poor study skills, test anxiety and lack of coaching are other possible causes**.** Research data revealed that study skills courses prepared students to be able to perform well at the university level. According to Wolfe (2009), with the advent of technological tools in the classroom environments, the researcher poses the question, that is, are postsecondary students purposefully aligned with pedagogical methods? Of course, in observing the reciprocity between teaching and learning at many educational institutions, there seems to be poor study skills being demonstrated among students. Particularly lecture comprehension is the major study skill which is lacking in students' learning activities. Focus groups with students, and semi-structured interviews done with both students and staff from the Universities of Kingston and St. George's in London demonstrated the importance of study skills knowledge (Fergy, Heatley, Morgan, & Hodgson, 2008).

Similarly, Crede and Kuncel (2012), study habit and skill measures are predictive of academic performance and should be considered for academic success. The hypothesis that poor study skills are related to students' inadequate knowledge of good strategies and/or to their inconsistent use has been shown to play a crucial role in successful studying (Meneghetti, De Beni, & Cornoldi, 2007). According to Lindblom-Ylänne (2007), in Finland it is mandatory for Helsinski University law students to do a course in study skills, so that they developed self-efficacy and independence. It is shown that these students normally perform better in their studies. A study skills module integrated into education program (i.e., higher education) enhanced students confidence, criticality, self-reflection and change as a learner (Allan & Clarke, 2007).

Similarly, Nolting (as cited in Boylan, 2011) revealed that math is like a foreign language, so one has to practice to be good at it. Furthermore, for most adult learners who have done math in many years on being matriculated for university studies they should be placed in math development classes. This will allow students to hone the necessary math study skills to move forward. According to Cahir, Huber, Handal, Dutch, and Nixon (2012), the attrition rate for new university students are higher than any other students, so there should be study skills programs for their educational development in universities. For example "Study MATE", which introduce new students to technological devices that facilitate learning techniques. According to Míreles, Offer, Ward, and Dochen (2011), the incorporation of study strategies in a college algebra course has proven to be a success. This was measured by a learning and Study strategy intervention (LASSI) scale. According to Kirwan and Leather (2011), argued that study skills support funding is very

important to the development of disabled students. In this case, the students regard the funding as helping them to understand dyslexia, specific learning difficulty, and finally to develop their problem-solving skills needed for studying. Gadelrab (2011) argued that academic achievement is to the internal consistency and predictive validity scores of study skills program "ASSIST".

Test Anxiety

For test anxiety, Fernandez-Castillo and Gutierrez-Rojas (2009) asserted that the variables: Anxiety, depression, and academic performance are associated. Specifically, anxiety and depression are positively correlated, while depression and academic performance are inversely correlated.

According to Putwain (2011), the Test Anxiety Inventory was administered to 690 students in the Year 10 cohort and 658 students in the Year 11 cohort, drawn from seven secondary schools in the Northern UK. The result showed that variance in the test anxiety scores of the students can be predicted from a number of socio-demographic variables. From a study of 175 sixth formers in pre-university degree courses in psychology and sociology, it was revealed that the self-regulatory model of anxiety is related to parental pressure and teachers' performance-avoidance goals (Putwain, Woods, & Symes, 2010). As a result, educators should be fully aware of test anxiety, since students' test assessments are normally used to make vital decisions of the learning progress (Salend, 2011). According to Birenbaum (2007), there is perceived relationship between instruction and assessment with respect to preferences and lent support to the integrated model of test anxiety.

In a study, Rezazadeh and Tavakoli (2009) revealed that female students are more test anxious than male students. The researchers revealed that fact by using a Suinn 48-item questionnaire as a numeric measure for 110 students at the University of Isfahan. However, According to Ndirangu, Muola, Kithuka, and Nassiuma (2009), a pre-and post-test administered to high school students from the Nyeri district Kenya showed that both male and female students are affected by test anxiety. This was demonstrated by a significant p-value of less than 0.01 and a t-value of -3.736. For a test anxiety inventory (TAI) the Cronbach's α = .81 to .94, which seems to be an appropriate reliability coefficient range of the measuring instrument. Also, a differential statistically significance between self-report measure of cognitive interference, for the worrying and emotional groups in Greek was revealed (Papantonioui, Moraitou, & Filippidou, 2011).

Nyroos, Korhonen, Linnanmaki, and Sylens-Liavag (2012) administered the children test anxiety scale (CTAS) in a cross-national study of grade-three children from Finland and Sweden, revealed that girls are more likely to suffer from autonomic reaction related to test anxiety. The researchers further posited that there was no significant difference in test anxiety as it relates to gender. Test anxiety should be considered at educational institutions because samples of 90 outstanding and non-performing students of different area of specializations at the Al-Hussein Bin Talal University have demonstrated to be tested anxious (Alrfooh &Tarawnih, 2012). According to Tooranposhti (2011), a *t*-test analysis has shown that students' test anxiety is related to parental academic education level. In this case, the author argued that students' test anxiety is directly related to parents' academic education levels.

Test anxiety causes a reduction of academic success and decreases students' confidence (Miesner & Maki, 2007). Orbach, Linsay and Grey (2007) stated that test anxiety is widespread and associated with poor performance in academic examinations. They posited that online treatment can be used to correct cognitive behavior therapy (CBT).Ramirez and Beilock (2011), exams and tests are very stressful to many students. In fact, some students actual choke at exams/test, and they normally perform less than their level of knowledge in the subject matter. Particularly, young adults demonstrate this weakness while performing math tests/exams. According to Larson, El Ramahi, Conn, Estes, and Ghibellini (2010), in an experimental study of two Midwestern elementary school, it was revealed that the relaxation intervention have significant impact test anxiety, thereby reducing an experimental group of 177 third-grade students.

Mathematics Instruction

Despite the No Child Left Behind Act (NCLB), whose mandate is to equip every classroom with a highly qualified teacher. According to Rosas and Campbell (2010), many math teachers are not able to show confidence in being able to provide proper math instruction; this was measured by completed undergraduate math courses at the university level. According to Bouck and Meyer (2012), the teaching of mathematics to students with visual impairments using electronic assistive technologies that incorporate the electronic would be of great assistance in certain mathematical language. Similarly, this approach would work well in my working area, which could improve students' mathematical competence. Roessger (2012) argued that a specific approach should be

considered to support how adults' best learn novel motor skills in formal educational contexts, which indicates that adult learners should be taught by special instructional design. According to Gargallo, Almerich, Suárez-Rodríguez, and García-Félix, (2012), there should be separate strategies being employed to teach average and excellent students, because of task or internal attributions in strategies. According to Lam, and Wilding (2012), speech dynamics should be considered by instructors, because an acoustic measure of speech will impact what students' hear.

Thanudca, Houksuwan, and Suksringarm (2012) explained for a web-based method called "Learning Together" has revealed that the method is appropriate and effective. In this case, a p-value of < 0.05 showed a significant level for students' gains in learning achievement. Peck (2012) asserted that new technologies in education offered the opportunities for collaboration and community learning instead of individual teacher or learner. According to Chang**,** Hagmann, Chien, and Cho (2012), the self-guided education pathway (SGEP) and the teacher guided education pathway (TGEP) when both compared, revealed that the TGEP approach provides high school students with significant higher knowledge achievements. According to Aguirre and Quemada (2012), inter-institutional collaboration learning via e-learning has shown to be quite successful in European and transatlantic universities. The authors asserted that this would promote e-learning as effective tool to foster dialogue education, which could perhaps impact the shortage of math and science instructors.

According to Jou and Wu (2010), technology is pertinent to demonstrate virtual-reality, which provides interactive learning on the Internet, which enables self-directed

learners' thinking to be pushed to a higher level. Ravikirti (2012) recent technique and approaches in education are having more effect than the traditional approach, which are enabling the reciprocity between teaching and learning. According to Tennant, Edwards, and Miyamoto (2012), collaborating librarian (i.e., between the library and the academic community) is an effective way to promote students' learning and the grading of assignments.

Prevalence of Math Anxiety

For math anxiety prevalence, Glaister (2007) used a group of 97 second year nursing students in a quasi- experimental study has shown that 34 of them suffered from mathematics anxiety. Hence, he recommended that special attention should be paid to instructional strategies whenever programs are being designed. According to Gresham (2008), there exists a significant relation between mathematics anxiety and mathematics teacher efficacy. This relationship showed a correlation coefficient (r) of – 0.475 Hanna, Chevlin and Dempster (2008) examined the structure of the statistics anxiety rating scale by surveying 650 undergraduate psychology students via an online study. The findings showed that the stats anxiety rating scale was found to measure the six sub scales that it was designed for in the UK population. According to Jain and Dowson (2009), 232 eighth grade students from India demographics (gender, age and marks scored in last math exam, and occupation of both parents were considered), that is, the motivating strategies for learning questionnaire and math anxiety scale. The findings revealed a structural equation model of math anxiety that was constructed and evaluated.

According to Henrich and Lee (2011), 20 and 28 humanity major students were studied respective in 2010 and 2011 at Seattle University. These students were sent to teach some primary students about the enthusiasm of math as an evaluating tool. Surprisingly, the University students had realized that their math anxiety levels were reduced after teaching the students. According to Chinn (2008), whatever the change in mathematics curriculum, there is always a problem with math anxiety of UK students. Over 2000 students in England completed a 20-item questionnaire, which was designed to investigate math anxiety level. This same instrument was used by 440 dyslexic students in specialist schools. Findings showed that over 4% were suffering from math anxiety. According to Collins (2007), many antecedents of statistics anxiety have been identified immutable. He posited that many of the intervention programs that have designed to reduce students' levels of anxiety are somewhat teacher-centered rather than student-centered. The findings revealed a strong multivariate relationship between reading ability and statistics anxiety.

Bekdemir (2010) studied a group of 167 pre-service senior elementary teachers and examined by using three different instruments: math anxiety rating scale; worse experience and most troublesome mathematics classroom experience reflection test; and interview protocol. The findings show that many pre-service mathematics classroom experiences have directly impacted math anxiety in pre-service teachers. According to Maloney, Waechler, and Risko (2012), math anxiety questionnaires were completed by undergraduate students and the results showed that females were more anxious than males, because of the female's special processing ability.

According to Olmez and Ozel (2012), a study of 120 and 124 grades six and seven students revealed that female students received lower math anxiety scores than male students. In addition, students who like their math teacher had significantly lower math anxiety. According to Carr and Steele (2009), stereotype threat was found to increase inflexible perseverance, that is, women made to believe they were taking a diagnostic math/special ability test compared to those who were not threatened by stereotypes. Those women with stereotype threat will perform poorly at solving math problems. Some person's working memory (WM) is associated with math anxiety and cortisol concentration. For low working memory individuals, there is no relationship between WM and math anxiety or cortisol concentration. However, for persons with high working memory and math anxiety, there will be a higher chance of choking after mathematical activities (Mattarella-Micke, Mateo, & Kozak , 2011).

Young, Wu, and Menon (2012) demonstrated that functional MRI study on 7- to 9-year-old children showed that math anxiety related to hyperactivity in right amygdale regions, which is imperative for inflicting negative emotions. So learning can be impacted negatively. According to Sloan (2010), certain module in math methods course can propagate preservice teacher's math anxiety levels. According Helal, Hamza, and Hagstrom (2011), a study of 120 college undergraduate majors revealed a correlation between math anxiety and achievement, but there was no significance between math anxiety and gender.

According to Devine, Fawcett, Szucs, and Dowker (2012), math anxiety, test anxiety, gender, and math performance are related. These relationships are as follows: (a)

levels of test anxiety and math anxiety revealed to be higher for girls than boys; (b) both girls and boys showed a positive correlation between math anxiety and test anxiety; (c) test anxiety was negatively correlated to math performance, but was shown to stronger for girls than boys. For this study, 433 British secondary school students were selected, who completed mental math test, math anxiety and test anxiety questionnaires. According to Betz (1978), results indicated that math anxiety occurs frequently and is more likely to occur among female and students with poor high school math backgrounds. Although there have been many years since the 1978 math anxiety publication by Betz, nevertheless, math anxiety seems to continue impacting a wide range of students in and out of the math classroom

For this research, it is assumed that positive social change through a student-centered approach in our educational system can be achieved. Therefore, an attempt was made by the mathematics department to correct each math student anxiety (which results in a high failure rate) by administering an intervention program. For many years, students' math failure rates have been a major concern to stakeholders both locally and internationally.

Implications

The major implications of this project study are: (a) the data collected and findings can be presented to all the tertiary institutions in Jamaica; (b) perhaps, data collection approach can be replicated in primary and infant schools' in Jamaica; (c) the publication of simple descriptive analysis of math anxiety in the Sunday News Papers (d) findings will sent to the minister of education; (e) to provide understanding of the

relationship between math performance and musical beats. With these publicities, greater awareness of our local math anxiety problem may be attained. Additionally, light will be shed on the importance of assessing students with learning challenges, particularly university students with high levels of math anxiety. In this case, the fostering of greater awareness of the importance of a student-centered educational system in my local area will be highlighted. In order to impact the education system in my local area, the problem of math anxiety students must be recognized by all the stakeholders (dean, lecturers, students, parents and ministers). The stakeholders will be informed through an unbiased scientific inquiry.

Summary

In summary, the aforementioned headings: research problem; research questions/hypotheses; rationale and literature review have provided essential components of this project study. However, the research problem will be used to answer the major research question, that is, what is the relationship between the mean precalculus test scores (dependent variable) of University students with different levels of math anxiety measured from the Mathematics Anxiety Rating Scale-Short (MARS-S) questionnaire and isochronic tones (independent variable)? The next section will review areas of this project study. Some of these areas are: research design and rationale; research setting, sample, and method; data collection instruments; data collection procedures; data analyses; benefits and limitations; and ethical considerations.

Section 2: The Methodology

Introduction

Research methodology deals with the information gathered, which was later analyzed. In this case, the numeric information from the study is presented to the audience for this wait-control quantitative design that was conducted by the mathematics department at a small urban university in Jamaica. Most of the literature that has been reviewed indicated that the precalculus math students had been experiencing symptoms of math anxiety. Additionally, math self-concept, math self-efficacy, and math anxiety are inter-related. A study of 41 countries revealed the aforementioned inter-relationship. Particularly, Japan and Korea demonstrated low math self-concept, low math self-efficacy, and high math anxiety, despite their high scores (Lee, 2009). A quantitative wait-control research approach shed light on the aforementioned problem at a small urban university. For this research, pre-and posttests were administered (see Appendices B through C); students' math anxiety and test scores were measured and recorded using these instruments.

Research Design and Rationale

For this secondary analysis of data collected using a quantitative wait-control group design, there were two major analysis techniques: the Pearson product moment correlation and the independent sample *t* test, which I used in the control and experimental groups of a sample of 48 participants (i.e., 27 in the treatment and 21 in controlled group) of adult students with varied levels of math anxiety at the small urban university. These adult students were at least20 years of age. For this study, there were

three data collection instruments: first, a math anxiety survey instrument comprising of a total of 30 questions; second, college algebra pretest and posttest instruments with two separate sections, 15 multiple choice questions in Section 1, and one objective type question in Section 2;And third, isochronic tones intervention provided by the math lab. A sample of each of the above mentioned instruments can be located through Appendices B to D. I assumed that accurate numeric data would be provided from the administration of a pre-established survey that was used to collect pre- and posttest scores. The timing of pre-and posttests was60 minutes in duration. Also, the treatment group listened to the beats for durations of 10 minutes. Initially, the wait-control group was randomly assigned by the toss of a coin. Thereafter, both wait-control treatment groups completed the math anxiety test and math pretest.

Subsequently, participants were offered a similar treatment, after the experimental group, that is; they were given the beats treatments for 10 minutes. Then the participants completed a posttest and anxiety test. Further details are provided below. At the small urban university, each semester is approximately 13 weeks. This study was conducive with the timetable of tests and university exam scheduling. Also, the 10-minute treatment sessions (i.e., 10 minutes duration for 12 weeks and three sessions per week) did not appear to affect lecturing/tutorial hours three times per week. Prior to the treatment sessions the research hypothesis was tested and after the treatment sessions the alternate hypothesis was tested. The research and alternate hypotheses were as follows: (a) Math anxiety (independent variable) is negatively correlated to students' math pretest scores (dependent variable), and (b) monaural beats/isochronic tones (independent variable) will

impact positively students' posttest for math anxiety and mean precalculus test scores (dependent variable).

Research Setting, Sample, and Methods

The research study was conducted at a small urban university. This institution is situated in the city of Kingston (the largest city in Jamaica), and is funded by the Jamaican government. The student population was approximately 4,000, with students' average age being 22 years. Most of the students complete their first degree within 4years.

To conduct this research study, permission was granted by all stakeholders (urban university's dean, president, research coordinator, research committee, lecturers, and students).Particularly, the dean sanctioned the timing of the intervention lab sessions for the students. In this scenario, a quantitative research method (i.e., a wait-control experimental study and a correlation survey) was employed by the mathematics lab, whereby two groups of students were randomly assigned into an experimental and a wait-control group. The experimental group was the first to receive treatment, followed by the wait-control group. Group 1was the treatment group and Group 2 was the wait-control group. The students in both Groups 1 and 2 were tested for 1 hour in the pretest. The treatment group listened to binaural/monaural beats for 15 minutes for a period of 6 weeks. Then, both groups were posttested for 1 hour. The wait-control group was given the opportunity to listen to 15 minutes of binaural/monaural beats for 6weeks and also they were again posttested for 1 hour. These groups represent only one math class. In this math class there were approximately 48 students from a population of approximately

1,000 introductory natural and social science students at the small urban university. A study of this group setting (i.e., 27 and 21 participants assigned to each group) did not affect the classroom learning because students were in their regular classroom group settings. According to Mann (2004), for a sample number (n =30) the t-distribution is applicable for inferential analysis. Under this condition the population was approximately normally distributed.

Data Collection Instruments and Materials

The numeric data in quantitative studies are collected by data collection instruments. There are two major types of instruments: pre-established MARS-S and precalculus/ College math 1A. In addition, the materials used in the study were (a) the isochronic/monaural beats; (b) 35 headphones; and (c) a pre-amplifier. For this project study, only pre-established instruments were administered to the participants, as follows:

The MARS-S (Suinn & Winston, 2003): This is a 30-item questionnaire with a high internal consistency and good construct validity. For this instrument, there are five options on a Likert scale. On this questionnaire the options are between 1 and 5, with 5 expressing the highest degree of anxiety and 1 the lowest degree. This means that the overall score for a math-anxious student would range between 150 and 30. Below is an outline of the MARS-S, precalculus/college math 1A instruments, and materials used in the project study.

Instrument (MARS-S)

- Name of instrument ---- MARS-S
- Type of instrument--- preestablished

- Concepts measured by instrument--- math anxiety
- Scores for the math anxiety were calculated from the options of the Likert scale, that is, from one to five, with 5 points denoting the most math anxiety score and 1 for the least will be calculated
- Details of reliability and validity are provided by the authors of the MARS-S as discussed in literature review section.
- Participants will have to complete a 30-item short version of the MARS before and after the study begins.
- Raw data information (i.e., MARS-S) will be provided in appendix D.
- MARS-S scores will be the independent variable.

Instrument (College math 1A)

- Name of instrument---- precalculus (College math 1A)
- Type of instrument--- pre-established
- Concept measured by instrument--- The participants' math performances
- The test retest reliability of the precalculus test (October, 2012) has been calculated from the formula: s.d $(1\text{-}r)^{1/2}$ = S.E.M (standard error measurement). This value was found to be 0.7965 from a study. The internal consistency of the items of the math test revealed that the scores for each item/question are equally distributed. As it relates to the construct validity, the significance, purpose, and use of the scores of the participants are pertinent for the quantitative design. In addition, the content validity revealed that the

questions and scores from these questions is a representation of the possible questions of the specified content.

- Participants completed a 15 multiple choice questions (MCQ) plus one objective type question before and after the study began.
- Raw data information (i.e., pre-and post-math tests) was provided in appendices B through C.
- The participants' math test scores is the dependent variable.

Materials

Standardized isochronic tones/monaural beats by Morry Zelcovitch (Certified Brainwave Entrainment Engineer) were stored at a special website. As stated before, monaural beats can be used to stimulate electrical activity of the neurons through frequency response process (Oster, 1973). This process is called brainwave entrainment. Recently, brainwave entrainment engineer Morry Zelcovitch introduced the Morry method. In this entrainment process, Zelcovitch uses isochronic tones (i.e., waves with deep amplitudes to create frequency responses). In addition, the isochronic/monaural beats are provided in digital form (mp3). These beats are considered to be the categorical variable, which is the treatment.

- One preamplifier--- This instrument allowed all the students to listen to the beats at the same frequency.
- 32 headphones

Data Collection Procedures

Only students with varied levels of math anxiety were randomly assigned (i.e., by flipping a coin and allowing the experimental group (i.e., 27 students were selected from a group of 48 students, if the coin shows head) by the lecturer of the course and not the researcher. In fact, this amounts to 56.25% and 43.75% respectively. Authors of the instrument consider a score of 75% as a high anxiety level.

The groups of participants with levels of math anxiety had accessed and completed the MARS-S questionnaire survey online in a computer lab. First, all the participants took both the MARS and pretest (see appendix D) before the first in-course math test in the introductory math course. Second, for 6weeks the experimental group was treated, then both experimental and control groups were post-tested in both math and anxiety tests (see appendix B through C). Then, from the 7^{th} to the 12^{th} week the wait-control group was treated, if they wanted to participate. After the 12^{th} week, they were post-tested in both math and anxiety tests, which showed a similar trend in students' test performances. For each week each participant was given three sessions of monaural/isochronic beats (10 minutes in duration); after 18 treatment sessions of listening to the beats/tones, the participants of the experimental group and the participants of the wait-control group took a posttest, after both groups received treatments. According to Handley, Schlllinger, and Shiboski (2011), a wait-control quantitative design improves the methodological rigor, that is, the controlled group can be used to access the degree of accuracy of the findings from the treatment group. In addition, this design addresses ethical concerns, with regards to the treatment and control groups.

The participants were alternatively treated and tested in their respective tutorial group, because the computer labs can only hold a maximum of 28 students. All participants used a pencil-and-paper method to do the MARS survey and math tests, while the treatment sessions of listening to the beats/tones was done via headphones (HPS3000) connected to a headphone pre-amplifier (HA4700), which is then connected to a computer with the saved wave files. The scores received in the MARS and pre – and posttest was recorded manually.

Data Analyses

The data from these groups was analyzed. The data was descriptively analyzed and presented using a scatter plot for precalculus scores and math anxiety and box plot to depict the difference in precalculus mean test scores obtained from the two different groups. Additionally, the data will be inferentially analyzed using the independent sample *t* test and the correlation coefficient *r* (i.e., a numerical value lying between -1 and +1). The correlation coefficient was used to test the relationship between the variables stated in the hypothesis (a): math anxiety (independent continuous variable) is negatively correlated to students' pre - math tests scores (dependent continuous variable). A t-test was employed to compare the mean test scores of the variables of the hypothesis (b): isochronic tones sound (independent categorical variable) will impact students' posttest mean test scores (dependent continuous variable). In the final analysis stage\ mean math test scores of the experimental and control/wait groups (i.e., the group's pre- and post-tested means) were compared to deduce the highest mean score of the two categories presented in the study. In this case, the guiding research question will be answered.

Results

The pre-test math, pre-test anxiety, post-test math, and post-test anxiety scores are presented in the tables and figures. Findings are discussed below.

Data Analyses

The overall data analyses (i.e., correlations, *t*-test, and multiple regressions) are presented in tables and figures (i.e., box plots, scatter plots, and graphs). In addition, footnotes were provided to further explain symbols and abbreviations so that consumers of research will be able to fully interpret the research findings. Of course, these analyses might be appropriately presented in the research project to be disseminated and correspond to the theoretical and conceptual frameworks of the study. In addition to descriptive and inferential statistics, both significance levels and standard errors are presented, which follows social sciences research data presentation standards. Also, preestablished instruments' reliability was considered.

Internal reliability (or internal consistency) for the math test was acceptable, with Cronbach's alpha coefficient of 0.79. The internal consistency reliability of MARS-S is 0.96. Table 1 provides a descriptive characteristic of the sample (i.e., gender and ethnicity) of the research study. Additionally, the difference in means for the experimental and control groups, that is, Group 1 and Group 2 respectively, were compared. These means and other descriptive statistics can be found in Table 2 and Figure 1.Table 3 presents correlations between math pre- and post-test scores and MARS-S, of the precalculus math students.

Table 1

Descriptive Characteristics of the Sample

	Total		Treatment		Control	
	n	Percent	*n*	Percent	*n*	Percent
Gender						
Female	37	77%	20	74%	17	81%
Male	11	23%	7	26%	4	19%
Black	48	100%	27	100%	21	100%

Table 2

Descriptive Pre and Post Math and Math Anxiety Scores

	Treatment		Control	
Variables	M	SD	M	SD
Pre_Math	34.3	11.78	24.6	12.2
Pre_Anxiety	73.1	19.2	76.0	23.0
Post_Math	64.7	20.7	41.7	19.2
Post_Anxiety	61.7	19.8	76.9	22.8

Note. $n = 27$ for treatment pre-test group; $n = 21$ for control pretest group. $n = 27$ for treatment posttest group; $n = 21$ for control posttest group.

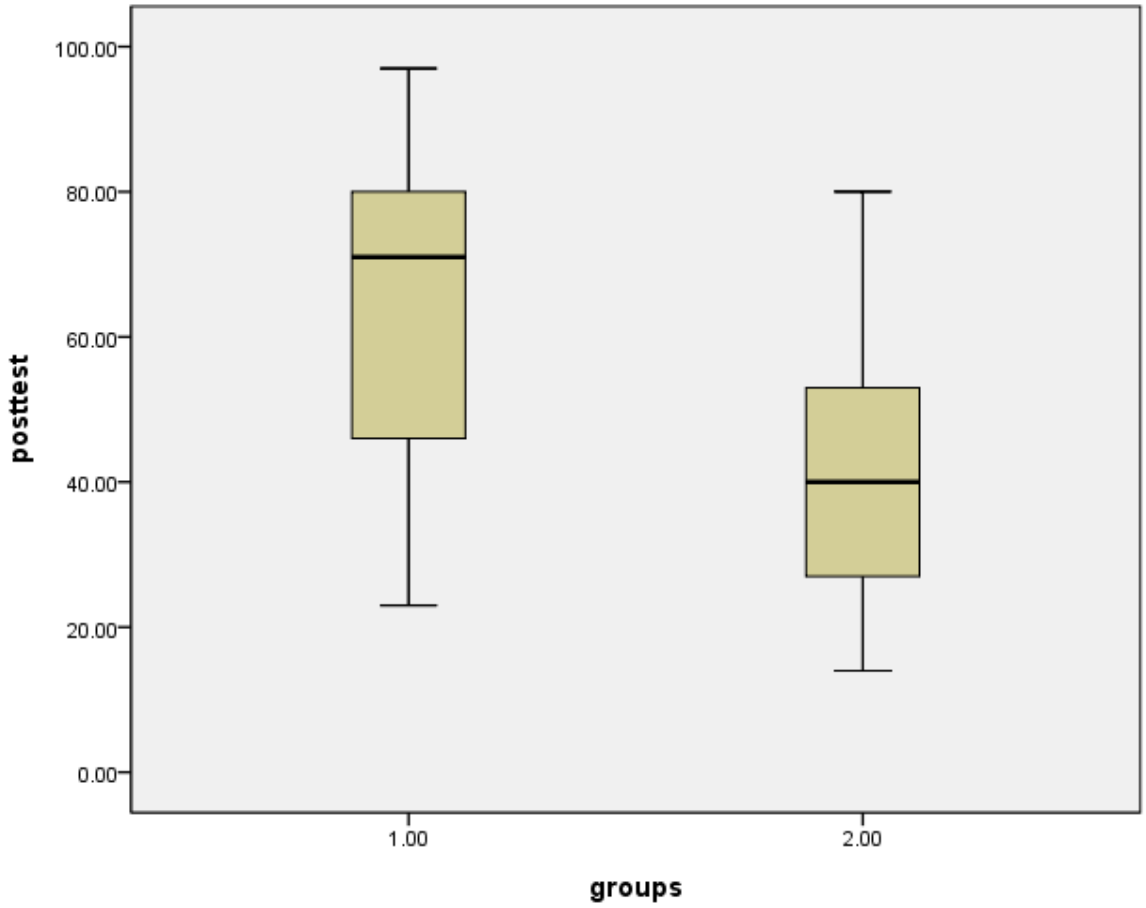

Figure 1. Comparison of means for treatment and control group.

Table 3

Correlations at Both Pretest and Posttest for Total, Treatment, and Control Groups

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1 Pre_Math	-	-0.21*										
2 Pre_Anxiety	-0.21*	-										
3 Pre_Math			-	-0.47*								
4 Pre_Anxiety			-0.47*	-								
5 Pre_Math						-0.39**						
6 Pre_Anxiety					-0.39**	-						
7 Post_Math							-	-0.26*				
8 Post_Anxiety							0.26*	-				
9 Post_Math										0.19*		
10 Post_Anxiety									-0.19*	-		
11 Post_Math											-	-0.35*
12 Post_Anxiety											-0.35*	-

Note. For total group $n = 48$; where treatment pretest group $n = 27$; for control pretest group $n = 21$; for treatment posttest group.
** Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Hypotheses

The research and alternate hypotheses are respectively: (a) Math anxiety (independent variable) is negatively correlated to students' math pretest scores (dependent variable), and (b) monaural beats/isochronic tones (independent variable) will impact positively students' posttest for math anxiety and mean precalculus test scores (dependent variables).

Hypothesis (a) proposed that there would be a significant negative relationship between math pretestscores and MARS-S scores for precalculus students. Consistently with my expectations, there was a correlation coefficient of $r(46) = -0.36$, $p = .002$, which is statistically significant. Therefore hypothesis (a) was supported. Additionally, Table 3 showed that student's pre -and post math anxiety and math test scores negatively correlated with insignificant p-values of greater than 0.05. Creswell (2009) asserted that fair correlation value of -0.26 and fairly weak values of-0.21 and -0.19, which that reflected the relationship between math anxiety and math pre-and post-test scores for the treatment and control group. Also, from Table 3, the pre math anxiety and math test scores for the treatment group was statistically significant, that is, $r(19) = -0.47$, $p = .05$

Next, the hypothesis (b) proposed that monaural beats/isochronic tones will impact positively students' mean posttest scores for math and anxiety. Table 4 provides the mean difference between groups 1 and 2 was statistically significant at the specified .05 level, with appropriate effect size (d). That is, $t(44.49) = 3.99$, $p < .000$, $d = 0.25$, 95% CI [11.39, 34.68]. Thus, hypothesis (b) was accepted, which means the null hypothesis was rejected and alternate hypothesis accepted. Similarly, Table 5 reveals that the post

mathematics anxiety of the students was statistically significant at the standardized .05 level, in this case, $t(39.8) = 2.42$, $p < .02$, $d = 0.70$, 95% CI [2.51, 27.86].

Table 4

Results of Independent t Test and Descriptive Statistics for Math Anxious Students Math Scores

	Treatment				Control		95% CI	
Variable	M	SD	*t*(46)	*p*	M	SD	LL	UL
Post_ Math	64.7	20.67	3.94	0.00	41.67	9.22	11.29	34.78

Note. $n = 27$ for treatment pretest group; $n = 21$ for control pretest group; $n = 27$ for treatment posttest group; $n = 21$ for control posttest group.
CI = confidence interval; LL = lower limit; UL = upper limit; d = effect size
**$p<.01$, two tailed

Table 5

Results of Independent t Test and Descriptive Statistics for Math Anxiety Posttest

	Treatment				Control	
Variable	M	SD	*t*(39.8)	*p*	M	SD
Post_ Anxiety	61.67	19.81	2.42	0.02	76.86	22.81

Note. $n = 27$ for treatment pretest group; $n = 21$ for control pretest group; $n = 27$ for treatment posttest group; $n = 21$ for control posttest group.
CI = confidence interval; LL = lower limit; UL = upper limit;
*$p<.05$, two tailed.

Besides, multiple regressions were not mentioned in my proposal as an analysis method to be employed in research study, mean differences for pre-test math scores were statistically and significantly different as there was more than a 10 point difference in pre-test scores in favor of the treatment group, in spite of the random assignment employed. Also, there were a few points difference between math anxiety pretest scores, though it was not statistically significant. Therefore, multiple regression analyses were employed to control for these pre-test differences in post-hoc analyses to see if results were statistically significantly different. While adding pre-tests as a control proved to change the coefficients as expected, there were still statically significant group differences in favor of the experimental group using post-hoc analyses. These findings are presented in Tables 6 and 7. Finally, Table 5 showed that math anxiety was increased for the students of the control group. Whilst those students in the treatment group had their post math anxiety reduced at a significant level.

Table 6

Summary of Multiple Regression Analysis for Variables Predicting Math at Posttest

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Constant	41.67	4.34		32.49	7.38	
Treatment	23.04	5.84	0.50***	19.42	6.22	0.42**
Pre_Math				0.37	0.24	0.21
R^2		0.25		0.30		
F for change in R^2		15.56***		2.35		

Note. $n = 48$ $^{**}p<.01$

***p<.001

Table 7

Summary of Multiple Regression Analysis for Variables Predicting Anxiety at Posttest

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Constant	76.86	4.62		81.57	12.51	
Treatment	-15.19	6.16	-0.34*	-15.34	6.23	-0.35*
Pre_Anxiety				-0.06	0.15	-0.06
R^2		0.00			0.12	
F for change in R^2		0.05			6.08*	

Note. n = 48
*p<.05

Levels of anxiety of the precalculus students revealed that the mean value is very close to the range of values that were indicated by the authors of the MARS-S instrument. This range (35 to 120) is seen in Table 3 and Figure 2. As such, the prevalence of math anxiety is confirmed. It can be seen that 25 percent of the students had anxiety (i.e., 17 students receiving anxiety scores 75 percent and over). Figures 3, 4, 5, 6, and 7 revealed the students' performances in the pre-and post-tests with and without treatment.

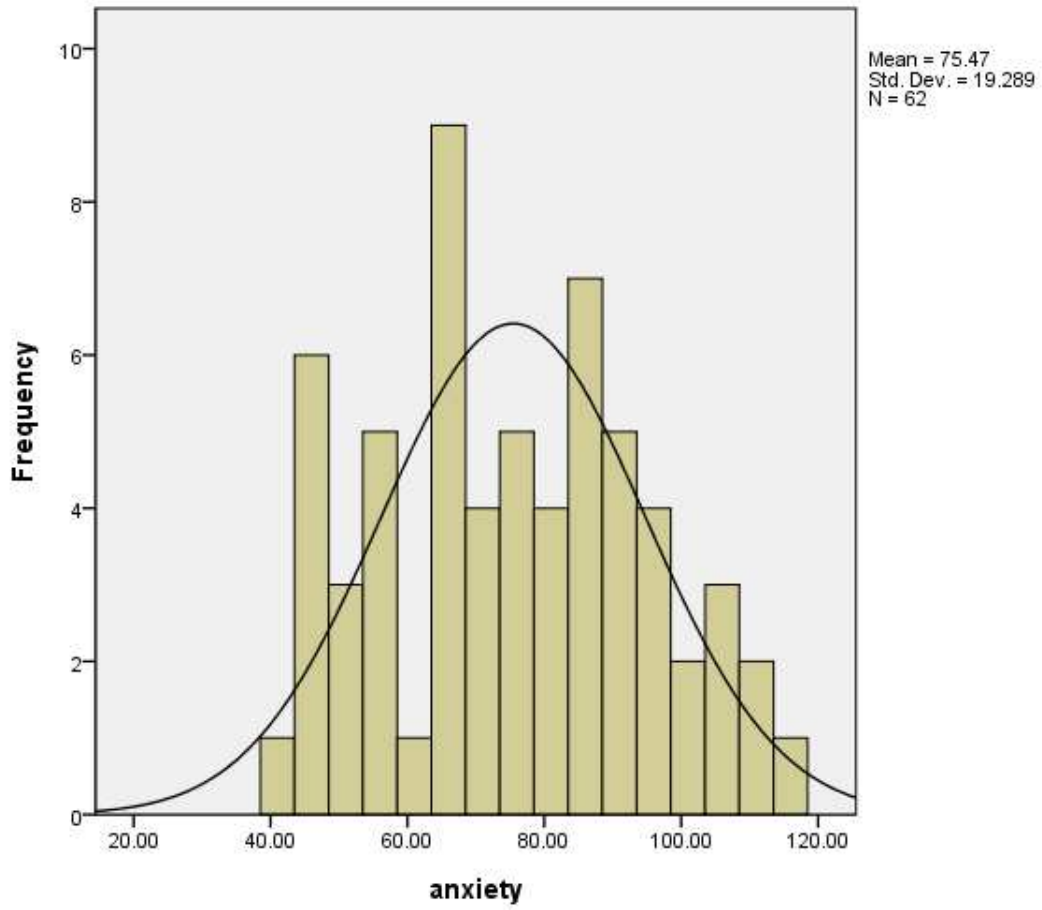

Figure 2. Normal distribution and histogram for math anxiety scores.

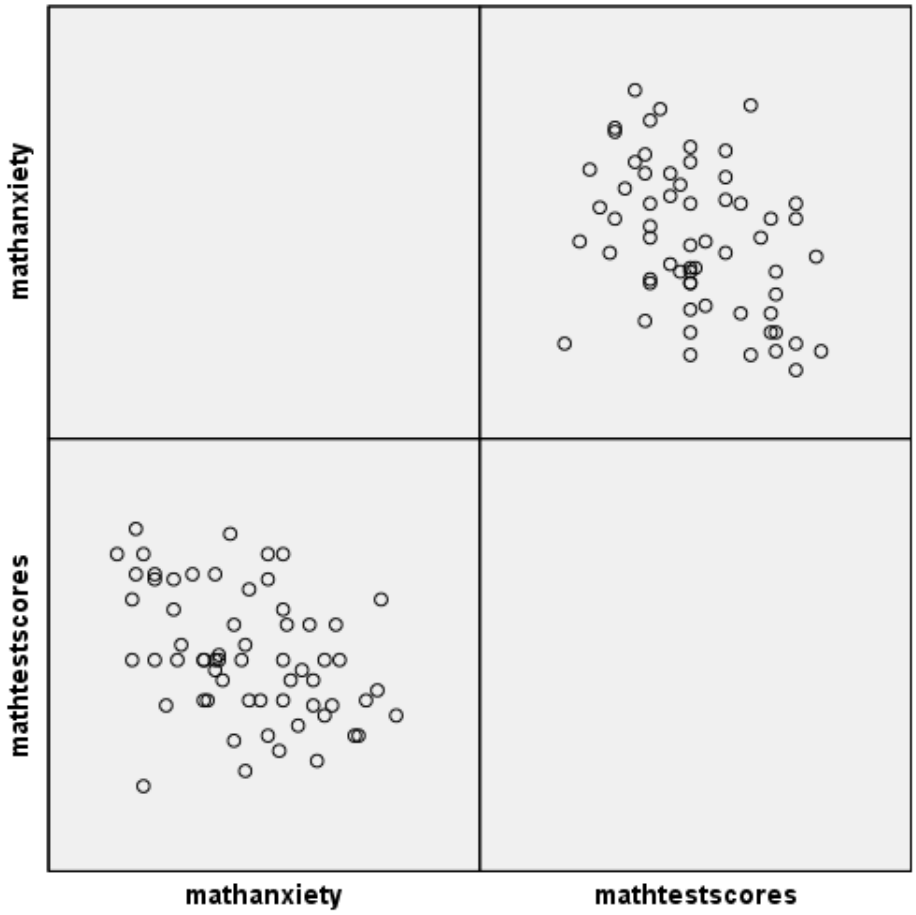

Figure 3. Scatter plot for math anxiety and math test (initial entire group, *N*=62).

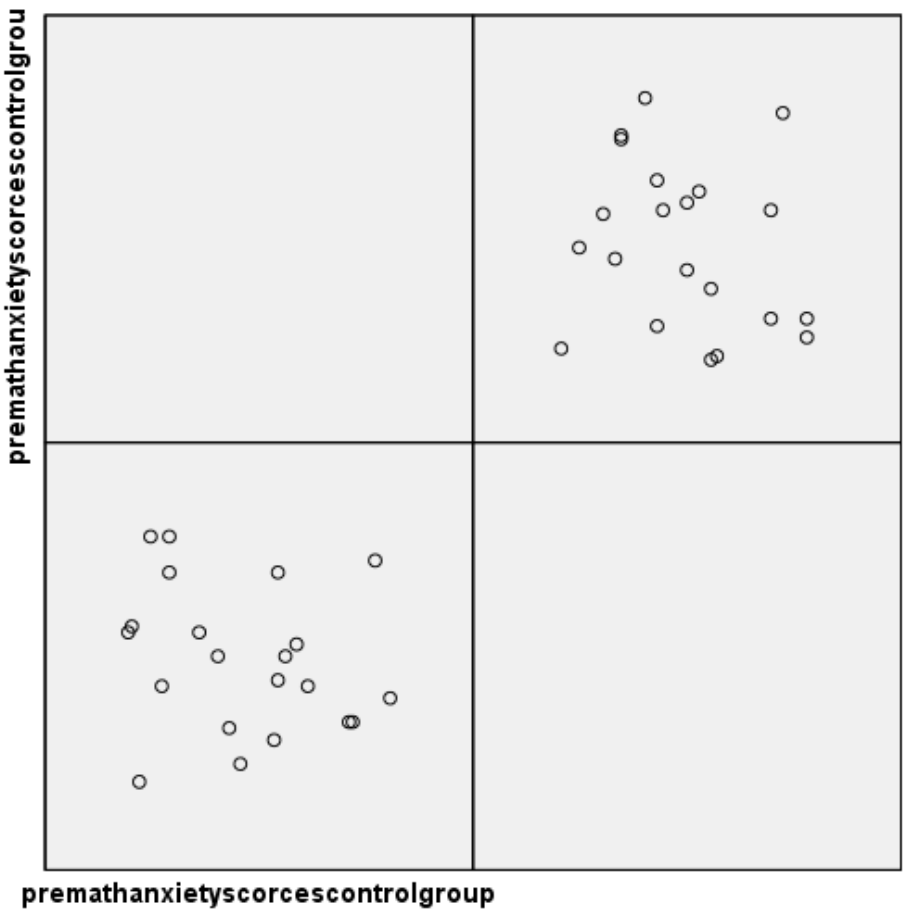

Figure 4. Scatter plot for pre-math anxiety and math test (control group, *N*=21).

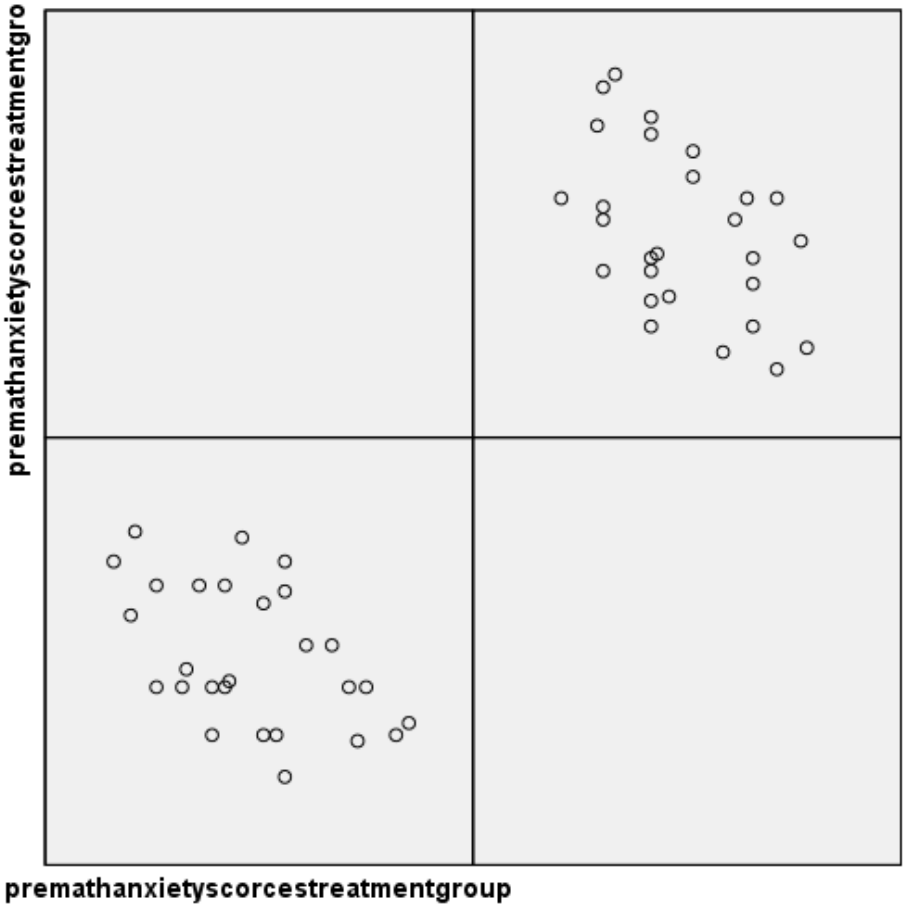

Figure 5. Scatter plot for pre-math anxiety and math test scores (treatment group, *N*=27).

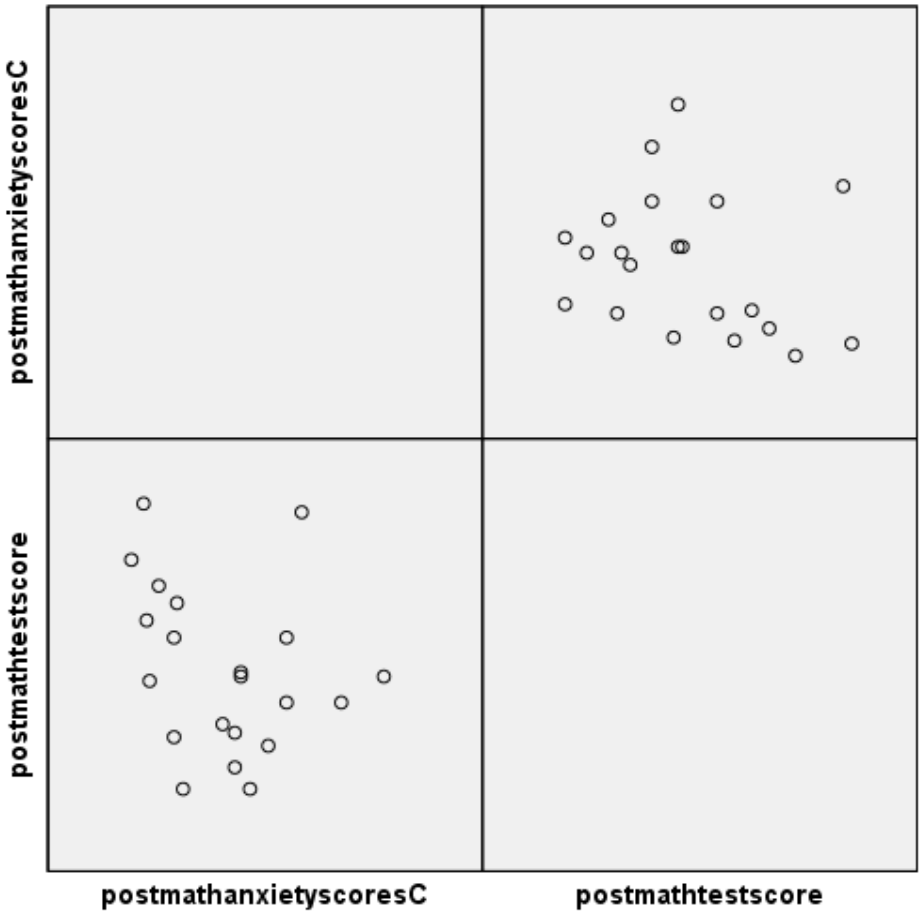

Figure 6. Scatter plot for post math anxiety and math test scores (control group, *N*=21).

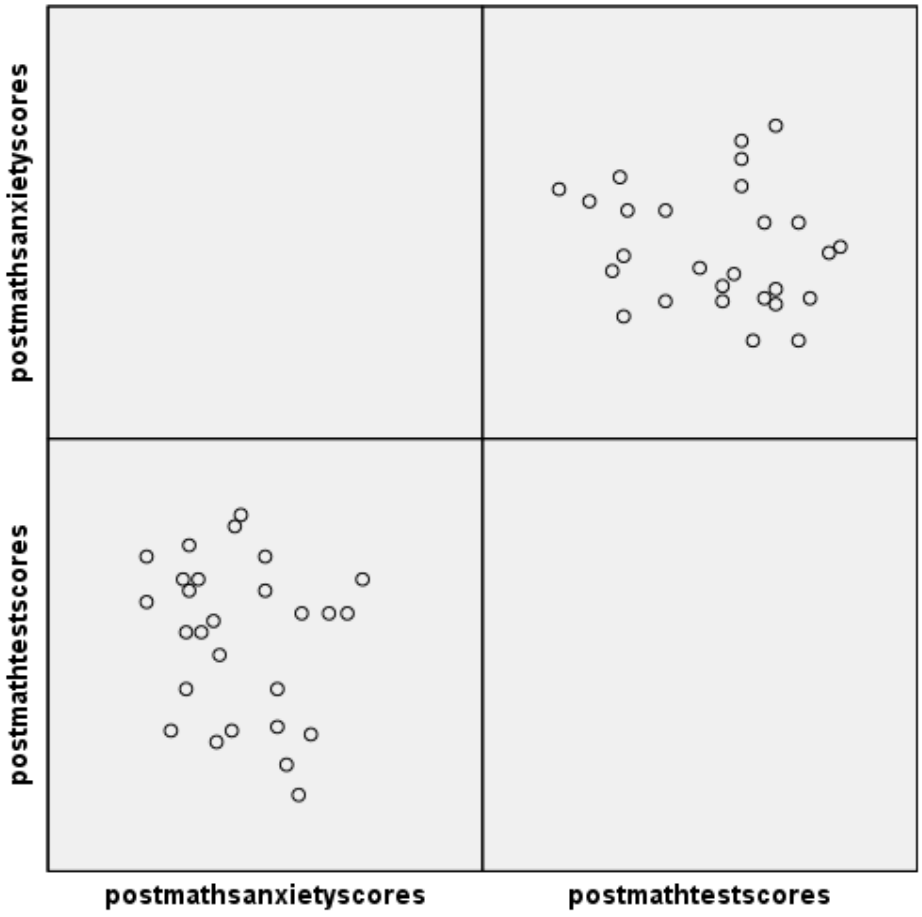

Figure 7. Scatter plot for post math anxiety and math test scores (treatment group, *N*=27).

Finally, the averages and standard deviations found in this research are, 64.70(20.67). However, while those in the control group received mean math test score and standard deviation of 41.67 (19.22) respectively. Additionally, the mean math anxiety score of 75.47 was found for the control group.

Discussion

Both research and alternate hypotheses were supported using proposed analytic method. The aforementioned hypotheses are: (1) Math anxiety (independent variable) is

negatively correlated to students' math pretest scores (dependent variable), and (2) monaural beats/isochronic tones (independent variable) will impact positively students' posttest for math anxiety and mean precalculus test score (dependent variable). Post-hoc analyses, holding pre-test scores constant, answered the second research question and, of course, the alternative hypotheses.

In other research, scholars support, and refuting the present findings (i.e., reduction of math/test anxiety) provided by this experimental study. In most cases the presented findings were consistent with this existing research. Sun and Pyzdrowski (2009) argued that math anxiety can be addressed through the use of technology. The beats for the reduction of math anxiety listened by the students in the math lab were not accessed from a computer software program. In fact, they were accessed as saved mp3's on the computer.

This research contributes both to a local problem as well as the research literature on music and anxiety reduction and cognitive stimulation. For example, according to Bradshaw, Donaldson, Jacobson, Nakamura and Chapman (2011), listening to music can stimulate emotional responses, and engaging cognitive attention. On the other, an intervention of listening to classical music did not decrease test anxiety or enhance exam performance (Goldenberg, Floyd & Moyer, 2013). Young, Wu, and Menon (2012) revealed that math anxiety was associated with reduced activity in posterior parietal and dorsolateral prefrontal cortex regions during mathematical reasoning. Hence stimulation of these regions could reduce math anxiety. Harmon, Troester, Pickwick, and Pelosi (2008) conducted two experiments from a sample of 72 participants. In experiment 1

some participants were exposed to Mozart music and in experiment 2 the other participants listened to rock music. The researchers hypothesized that those who listened to rock music would score less in a reading comprehension test. It was later proven that neither of the experimental group's results was significant. Finally, Jancke and Sandmann (2010) concluded that of the five groups selected from 75 participants listening to background music of varied tempo in a research study. The results showed neither an enhancement nor decrease in verbal learning performance. All in all, most research findings demonstrated that through selective of sound/music, sound stimulation can improve cognitive abilities. Music can inform broad theories of higher order cognition, for example, music in humans, that is, neuroscience of music (Levitin & Tirovolas, 2009). Pannese (2012) argued that neuroscientific evidence confirms that the aesthetic response to music is automatic, for example, motor synchronization, and increased heart rate. In these cases anxiety is impacted. According to Foster (2009), "music is a powerful medium, its effects can calm us, persuade us, especially when we cognitively impaired" (p. 1), hence can be used as a tool to improve cognitive.

Further discussions will be done descriptively. To discuss the findings of the research, three important points will be examined from the descriptive statistics figures. First, students' scores from the MARS-S can be compared before and after the treatment sessions. The comparison of students' scores can be shown in Figure 1. Second, there is an indication that isochronic tones do help in the reduction of math test anxiety, therefore increasing students test scores. In fact, this can be seen from the box plot in Figure 1. Perhaps, it can be used for other subject area. Third, a certain level of anxiety is needed

for students to perform at high level. Ratanasiripong and Kathalae (2012) demonstrated with a group of 60 participants nurse students in an experimental study, with 30 in treatment and 30 in control groups respectively. The treatment group students were train trained for five weeks to manage their stress and anxiety using biofeedback, while the controlled group used no mechanism for treatment. The results revealed that the treatment group performed better in the final exams. Also, that the controlled group stress and anxiety levels increased significantly. Rana and Mahmood (2010) demonstrated with a sample of 414 students from the University of Lahore, Pakistan, using the test anxiety inventory that their anxiety levels are inversely proportion to students' achievement scores. In this research, the linear regression analyses and person correlation were employed as inferential analysis tools. Mounsey, Vandehey, and Diekhoff (2009) explored 110 working and non-working students in terms of mental health and academic achievement by using the Beck anxiety Inventory and the Beck Depression inventory-11 Academic achievement, measuring grade point average. Data analyses revealed no significant difference in depression levels; however, the working students displayed greater levels of anxiety than non-working students. In these examples, above a particular average value students' performances will decline. This particular value can be easily identified from the normal distribution curve in Figure 2.

In addition, feedback from approximately 41 students provided information on a six item questionnaire (i.e., shown in Table 8) about additional measures that could be taken to reduce the high precalculus failure rate of introductory students. The feedback received from the students in the math lab is worthwhile considering there may be

extraneous factors that contributed to the treatment group's improved performance. The items on questionnaire (i.e., Appendix E, with six closed ended question items)that the majority of the pre-calculus students responding (as shown in Table 8) when asked what they would like more information on are: (a) test strategies and notes taking, 78.1% respondents answered yes; (b) instructional strategies, which was represented by 100% of the students saying yes to the closed ended questions; and (c) motivation, 73.2% answered yes.

Table 8

Summative Students' Feedback Questionnaire

Question:	Respondents answering (Yes)	Respondents answering (No)	Respondents percentage (Yes)	Respondents percentage(No)	*n*
Time Management	30	11	73.2	26.8	41
Study aids and note taking	32	9	78.1	26	41
Test strategies	39	2	95.1	4.9	41
Other ways to reduce anxiety	31	10	75.6	24.4	41
Motivation and attitude	31	10	75.6	24.4	41
Instruction method (tutoring/ after school help)	31	0	100	0	41

Note. Questionnaire feedback of likely ways of improving math performance form introductory precalculus students in the math lab, $n = 41$

Summary

In summary, the results (i.e., *t* test and correlation) of this research shed light on the guiding research question, that is, to show the relationship between precalculus test

scores and isochronic tones, an effect size value was calculated, which is 0.25. The effect size (*d*) showed that the students who were treated with isochronic tones received mean math test score with standard deviation of higher values. However, while those in the control group received mean math test score and standard deviation of lower values. Additionally, the mean math anxiety score was higher than normal accepted of 75% attained by students in the study confirms that the math anxiety problem does exist among the introductory precalculus students.

As a result of the outcome of this research study, a project of the intervention that reduces math anxiety and improving math test scores of introductory math students can impact many lives positively. In this case, audio brain stimulation for students who are motivated and understand the importance of test strategy skills, with good math attitude can be promoted. Furthermore, arts education (i.e., audio, music, and performance arts) have been hot topics of discussion among educators/researchers to reduce high failure rates in the math classroom. Results from a questionnaire that was completed by precalculus students in the math lab have been highlighted in Table 8.

Assumptions, Limitations, and Delimitations

This study provides scientific inquiry into a mathematical problem found in a local area. There are four assumptions made in conceptualizing this research proposal. First, it is assumed that the students will be honest in answering the math anxiety survey. Second, it is hoped that the students' anxiety survey scores will dispersed from 75% to 100%. Third, it is assumed that the collected numeric data will be normally distributed.

Fourth, the wait-control design will allow a selection of students' experiences, which will provide necessary feedback about the intervention program.

The limitations of this study are that (a) results may vary since brain-wave stimulation can vary with the person's state of mind; (b) accurate results depend upon students being honest in answering the math anxiety survey; and (c) eighteen 10-minute sessions might be too short, it would be better to treat the participants over longer sessions, for example 30-minute durations, because greater brain entrainment can be attained (Huang & Charyton, 2008). Also, in this study there were four variables: (a) students' pre-math anxiety scores; these scores will be the numeric independent variable and students' pre- math test scores, which will be the numeric dependent variable; (b) categorical variables, these variables are monaural and isochronic tones; which will be independent variables and students' post-test scores, which will represent the numeric dependent variable. The aforementioned variables measured the numeric and categorical data that were collected in the research study. The range of the independent variables (i.e., math anxiety test scores and the categorical data) are: First, the range of the math anxiety test scores were considered from a low of 75% to a high of 100%. Second, for the categorical variables, the students had a maximum of 15 minutes for listening toisochronic tones. If students test scores or duration of listening were outside the range determined their data were excluded from the study

Next, the occurrence of treatment infidelity or poor treatment implementation, discussed in Chapter 2, could impact the statistical conclusion validity of the results. Lastly, all the data for this study will be collected via, test taking format. Thus, this

method of data collection might cause concerns about the construct validity of the tests (i.e., math anxiety and math tests). Furthermore, the intervention program perhaps worked as alternative mechanism, and not the usual instructional approach but therapeutic approach. Since the students at times were exposed to high levels of stress at work during the day. It is important to relax them with the monaural beats/isochronic tones before the start of math lectures. As a result, may be intervention program was successful in its application. However, there were some students in the research study who attended classes in the days, as such; the beats/tones were not successful as a treatment for anxiety reduction. In this scenario, there were concerns about the implementation of the intervention program, because of background characteristics that might affect the anticipated outcomes of the experiment were not measured or taken into account for this study.

Despite the possible threats to validity, the alternative hypothesis was supported. Hence the findings are considered by this researcher to be important to share with the stakeholders in the field of education both at the local level and more generally. The problem of high failure rate in math can be tackled by promoting a greater awareness of the problem. This research provides some evidence to a promising solution to reduce math anxiety and increase math test scores, but unfortunately it is not solve the larger problem, Thus, it would be important embark on far more wide ranging research based projects to reduce math anxiety and improve both math skills and math test scores in the local population.

Ethical Considerations

An IRB application was submitted to protect the participants from harm, ensure confidentiality, and uphold U.S. federal laws. The following ethical standards were be upheld by the department of mathematics: (a) research was monitored, since time and students' test scores were required variables for the quantitative design; (b) all the participants signed or submitted electronic signatures to the informed consent document; (c) research participants were assigned code numbers to identify their test scores or any form of responses/feedback; (d) the collected data was stored in the dean's office (i.e., in a secured cabinet), and was destroyed upon completion of the analyses; (e) the participants were taught by lecturers other than me; (f) both groups of participants were given treatments; (g) participants' involvement in the study was strictly voluntarily, which gives them the right to refuse to participate; and (h) participants had the opportunity to discontinue participation in the study at any time; (i) each student was asked an open ended question, that is, what else do you think might be helpful in order to perform better in his/her math precalculus test; (j) students were not be exposed to sound intensity greater than 12 db; (k) the test questions were marked and graded by an independent lecturer (Rowe, 2014), who is the head of the School of Math and Statistics. The study was conducted by someone other than the researcher, who conducted data analyses of the study, which were released to him by the Dean. Finally, the participants' rights were considered both before and after the research were conducted. Therefore, no harm or any abuse to the participants' confidential affairs appeared to be inflicted.

Conclusion

In summary, the outcomes of the research study are two–fold. First, the treatment group has shown significant difference in math test scores after they were treated with isochronic tones. Second, students' pre-math test scores were inversely proportion to pre-anxiety math scores. Theses outcomes are aligned to the guiding research question, that is, what is the relationship between the mean precalculus test scores (dependent variable) of University students with different levels of math anxiety measured from the Mathematics Anxiety Rating Scale-Short (MARS-S) questionnaire and isochronic tones (independent variable)? All in all, the results of the research study were significant at the appropriate levels in the field of social science.

Based on the results obtained in this research, it would be important to make recommendations to stakeholders to introduce the anxiety reduction program into schools' diagnostic tests. This approach would help many students who are mathematical anxious. As such, the proposed project (i.e., policy recommendations) of reducing student's anxiety should be implemented, also to improve students' math competency in precalculus.

Section 3: The Project

Introduction

From the findings of the research, the project was crafted to address two overarching issues: (a) reduction of math anxiety and (b) suggested ways of reducing high math failure rate proposed by students based on data from a questionnaire. Finally, this project, entitled "Reducing Math Anxiety through Musical Instrumental Tones" (RMATMIT) is intended to provide information to the key stakeholders (i.e., the minister of education and dean of Faculty of Science and Sport [FOSS].

Description and Goals

This project genre is a policy evaluation that will provide a statement of the problem of low math scores and high math anxiety at the local level, the need for the study that was conducted as a result of identifying the need, the results of the study that was conducted, feedback from the students participating in the study, and implications for further research. Implications for further research include both further research with regard to binaural beats/isochronics tones and further research and a proposed action plan regarding mathematics preparation.

Also described are implications of the research to the greater community and key stakeholders, which include an awareness through policy recommendations of (a) beats/tones/music that can reduce math/test anxiety at an urban local university, (b) the ways of improving low level of mathematical skills/competency, and (c) the importance of reducing of math/test anxiety at the university level to stakeholders (minister of education, dean of faculty, parents, and students) through appropriate teaching and

learning styles. The policy recommendation will be based on the findings from this research study. Furthermore, in spite of the intervention, findings revealed that math skills were still low. Thus, stakeholders would be fully aware that more needs to be done to address the major concerns about the university precalculus students' challenges, which include, but may not be limited to, providing further support and instruction in the areas of time management, math performance and skill building, note taking, math motivation and a positive attitude, and other ways of reducing math anxiety that include curricular, instructional, and noninstructional approaches.

At a small urban university, the introductory math courses (i.e., college algebra and precalculus) showed a high math failure rate. I assumed and later hypothesized that the high failure rate was a result of math anxiety affecting the students. The need for this math crisis to be addressed is of national importance, because the international monetary fund has been made available to Jamaica under certain condition, that is, there should be reduction in public sector non-technical workers (Country Report, 2013). As a result, the Chinese government will be collaborating with the Jamaican government to establish a high technology transshipment hub, where thousands of workers will be employed. As such, only mostly qualified technical persons will be employed (i.e., those with good math background).

The purpose of the quantitative research study was to examine whether math anxiety can be treated through isochronic tones. With better math performance at the university level, it is predicted that more students can get jobs in technical or professional fields. In this secondary analysis of data based on a pre-and posttest wait-control group

design conducted by the mathematics department at a small urban university in Jamaica, two groups (i.e., n= 48) of introductory precalculus, math students displaying different levels of math anxiety were treated in 18 10-minute sessions with isochronic tones. The study investigated differences between two groups (i.e., a control and an experimental group) of students with math anxiety, one treated with brain waves entrainment intervention for that anxiety with the second group working on math tutorial questions. I tested the following hypotheses: (a) Math anxiety is negatively correlated to students' pre-math tests scores; and (b) isochronic tones will impact students' posttest math anxiety as measured by Suinn and Winston math anxiety test and math scores as measured by standardized math test. The findings revealed that the treatment worked. First, a correlation coefficient of $r(46) = -0.39$ was significant at the 0.002 level for pre-math test and pre-anxiety. Second, the mean difference between Groups 1 and 2 on math measures favoring the treatment group was statistically significant at the specified .001 level, $t(44.49) = 3.99$, $p < .000$, $d = 0.25$, 95% CI [11.39, 34.68]. Third, for post math anxiety, the mean difference between Groups 1 and 2 was statistically significant at the specified 0.05 level, $t(38.9) = 2.42$, $p < .02$, $d = 0.70$, 95% CI [2.51, 27.86] favoring the treatment group. Thus, the treatment was found in this study to reduce both math anxiety and improve students' math test scores. This study impacted positive social change by helping to provide a mathematics test taking experience for students locally, that is, less anxiety producing and more positive in terms of mathematics outcomes. Although p-values for the hypotheses were significant in the research study, far more research is needed in this area.

Additionally, feedback from the students on a self-developed, single-ended questionnaire with six items (i.e., in Table 8) has shown that it is important to improve their math basic competence. In fact, they indicated that any additional help to improve math skills would be highly appreciated. It is pertinent for students to improve math competence. Indeed, this would have positive implications in the workplace: (a) more Jamaicans could be employed in areas that are normally occupied by foreigners, (b) the GDP could be increased, (c) crime and violence would be reduced because more persons could be employed, and (d) obviously, the sample number is small, so in the near future a larger sample will be randomly selected for the next research study, enabling generalization. Overall, the goals of this project are as follows:

1. To bring about positive change in math learning and teaching in order to positively impact unemployment
2. To create a national awareness of math anxiety and ways of reduction via online access to website.
3. Recommendations to implement new instructional approaches, curriculum strategies, and a more student-centered approach to mathematics education.
4. Initiating the platform for more research studies to be done in this area.

Rationale

This project was chosen because many instructors complained about the incompetency of their students in doing basic math tasks, which was reflected in a high failure rate in math. Additionally, with better math competency students can take up job offers in technical mathematical and scientific areas, because of the current scarcity of

employment globally. In order to address the aforementioned local issues, I designed doctoral research study to address these issues. The number of students that were considered for this project was 48. This number was appropriate for the research study. As a result, the *t* test was employed for data analysis because the *t* test can be applied to a sample number of 30 participants. The other analysis that was used is the Pearson correlation, which was appropriate because all the students' data were collected in each lab session. In the math lab, the design of the instrumental isochronic tones apparatus enabled all the students to receive treatment via headphones at the same time. By administering the treatment to the students in this manner and in analyzing the data, the extent of the reduction of students' math anxiety after the posttests will be shared with stakeholders. Further, recommendations based on the research will be made to the respective stakeholders. It is hoped the students' math anxiety can be identified and treated in local schools after further research is conducted. It takes persons with authority to enact curriculum and instructional changes in terms of educational reform.

Review of the Literature

Analysis of Research and Theory about Project Genre

In order to access the articles for this literature review selective online search of the database from Google, Scholar, Google, and Walden library current journal peer reviewed articles was conducted. The searching process was done by Boolean searching method (i.e., NOT, AND, OR selections and a combination of AND-OR and OR-OR). The key words that were used are: math anxiety, math achievement, math instruction, music psychology, learning methods in mathematics

The project to be analyzed is the policy evaluation in the field of education. Some of the major structural theories underpinning this project genre are: (a) game theory, (b) backward inductive theory, (c) Kingdon's (1995) agenda-setting theory. This theory states that agenda setting is the first stage in the policy process (Evaluation Based on Theories of the Policy Process, 2007).Although game theory is highly applicable in field of math, it is quite applicable to psychologists in the field of social science. Game theory was first introduced in 1944 by John Von Neumann. This theory states that one player's ability to win a game is critically dependent on the inputs of the other players. From game theory, the backward design is evolved. Backward design is to consider program/project outcomes at the start of the conceptualization process. These theories will be able to guide and shed light on the development of this proposed project. According to Vella (2009), it is very important to consider the outcome of a project/program before it commences. Also, Daffron (2008) stated that the project outcomes are assessed at the end of the project, while the objectives are benchmarks to be achieved during the project, which are listed in the above in the rationale. These outcomes are aligned to the mission statement (which is a form of management theory) of local university which is to provide educational opportunities, research, and consultancy in science and technology in order to advance industries, health care, and business (Utech, Purpose and Objectives of Faculty, 2009). Additionally, the Minister of Education mission statement is to provide strategic leadership and policy direction for quality education for all Jamaicans to maximize their potential, contribute to national development and complete effectively in the global economy. It is hoped that problem of

this project study can be addressed by upholding the fundamental principles of the urban university and the ministry of education through policy evaluation.

A policy evaluation is a systematic process for assessing the design, implementation, and outcomes of public policies (Anderson, 1994; as cited in Hall, 2014). Two main types of policy evaluation are formative and summative evaluation. Evaluation is done in social science research approaches, including qualitative and quantitative techniques to examine the effectiveness of policies. Below is a discussion of research-based analyses, interconnection between analyses and content of project which is math anxiety reduction, and hence improving math scores through proper management of time, improving math attitude, motivational coaching, and learning study skills.

In this evaluation the analysis of posttest outcomes on an algebra proficiency exam finds no effects in the first year of implementation, but finds evidence in support of positive effects in the second year. That is, for most mathematical instructions the teaching outcomes are noticeable over few years. The estimated effect of the algebra course is statistically significant for high schools but not for middle schools. Nevertheless, in both cases, the magnitude of the positive teaching impact is enough to improve the median student's performance by an eight percentile points(Pane, Griffin, McCaffrey, & Karam, 2014). Moss, Yeaton, and LIoyd (2014) conducted parametric and nonparametric analyses on a sample of 2122 at a large Midwestern College for the teaching of developing mathematics, yielding increases that generally ranged from one quarter to one third of a grade point, for a 1 to 4 grade scale. The within-study findings from the randomized experiment (RE) further established the credibility of regression

discontinuity (RD) to produce unbiased estimates. Implications of additional validity threats were considered to be eliminated in this embedded design, that is, (R-RE-D). In order to ensure that student's graduation rate does not lag behind students' attendance rate it is imperative that the university facilitate coaching sessions. The coach normally contacts students regularly to develop a clear vision of their goals/objectives, to guide them in connecting their daily activities to their long-term goals, and to support them in building skills, including time management, self-advocacy, and study skills. In essence, coaching is more cost effective to reduce attrition rate rather than other financial aid interventions (Bettinger & Baker, 2014). Coaching would be a math support system to be introduced at the urban university in Jamaica, because it could help the poor performing students to receive better grades in mathematics in their math tests.

Jacob, Goddard, and Kim (2014) posited that public use of aggregate data is sufficient and appropriate (a) when means and standard errors differ between models that use individual student-level data and those that use aggregate school-level data, (b) the potential for conducting subgroup and non-experimental analyses with aggregate data, and (c) the metrics that are currently available in state public-use data sets and the implications these have for analyses. In fact, these metrics can suffice quantitative evaluations for non-experimental research.

It is evident from the above policy evaluation analyses that the methods used in evaluations, including regression models, pre-test and post-test experimental designs, estimation of means, and nonparametric approaches, are similar to analyses techniques used in this project study. This explains that the analytical approach and results obtained

from the secondary data analyses used in this study are appropriately aligned to address the research questions posed in Chapter 1.

Analysis of How Research and Theory Support Project

Intervention theory is used in social studies and social policy refers to intervening effectively in a situation in order to secure desired outcomes. Advancing cognitive science requires a good understanding of how interventions are informed by, and test, theory (Michie, 2010), the findings of the project study revealed that math anxiety is evident among 70% of the introductory university students that were studied. Specifically, the research hypothesis in this project study has shown that math anxiety is negatively correlated to students test scores. Berger and Calabrese (1974) introduced the uncertainty reduction theory (URT). This theory is based on the human's thought process and their social implications. Surawy, Mcmanus, Muse, and Williams (2014) posited that mindfulness –based cognitive therapy (MBCT), could be used as an alternative method in treating peoples' anxiety issues. And depending on severity of math anxiety, it may be appropriate to refer students to a mental health professional to those with anxiety.

Further Research of Beats to Reduce Anxiety

Thorn-well et al. (2014) argued that neuron development disorder can be treated with musical sound as an external stimulus. Similarly the results of this project study provided exploratory data analyses to verify this musical response phenomenon. As discussed in section 2, math anxiety students normally experience an increase in heat rate whenever they are performing math related learning activities. In a survey of 36 randomly selected students, these students assigned to two groups. One the group listened

to a fast tempo song and the other group listened to a slow tempo song. Results has shown that the students who listened the slower song for a 2.5 minutes period had their heat rate decreased after a one minute interval of time after listening to the song (Agrawal, Makhijani, & Valentiti, 2013).

In essence, beats/tones could be employed to reduce math anxiety, as was demonstrated in the math lab. In the math lab the laboratory technician uses isochronic tones to stimulate the neurons of the brain, which is actually the brain wave entrainment. The findings of this project study confirmed that some student's anxiety level was reduced significantly. Similarly, in another recently published study, a magnetoenhalogram was used to identify high-gamma waves of frequency (52 –100Hz) in a sample of 41 elderly participants who demonstrated that the attentional process in a 3-stimulus of oddball task differ in their cognitive age (Akimoto, Nozawa, Kanno, Ihara, Goto, Ogawa, Kambara, Sugiura, Okumura, & Kawashima, 2014). In this case, brainwaves entrainment done by faster vibrational frequency might reduce anxiety quicker. Finally, the notion of hierarchically organized acoustic detection arrangement (i.e., prime tone frequency of 250 to 276 Hz between the ears to produce the perceived deviant-beat) can be used to replace the classical binaural beats entrainment, which are waves with slightly different frequencies being superimposed on each other (Chakalov, Paraskevopoulos, Wollbrink, & Pantev, 2014). A 64-channel and a dichotic listening task in 25 participants demonstrated neurophysiological mechanisms in conscious audio perception. This was identified within the gamma-band range during interhemispherical synchronization within the auditory cortices (Steinmann et al., 2014). Usually, beta

stimulation (i.e., neurons vibrating with 16 to 45Hz) enables the beta waves entrainment which is essential for problem solving and reasoning skills development. Since gamma stimulation is approximately 50 to 100Hz, stimulating it could improve students' math test scores. Hence, a higher mean math score could be reflected in the findings of the project study.

The listening of beats/tones is two-fold. First, Russio, di Bernardo, and Sontag (2010) argued that entrainment to periodic inputs/stimulus will cause the timing and sequencing of reactions. Similarly, in the case of sound waves being listened to by a person, the neurons of the brain will move at a frequency similar to the frequency of the periodic sound waves. Second, in psychodynamic theory a person experiences unconscious internal forces, which causes both emotional and physical reactions. As such, students who are test anxious should be treated in therapeutic treatment sessions. Similar to isochronic tones, which are filtered binaural beats used as the intervention program some further research are recommended, these include: One major treatment is through relaxation. Weiland et al. (2010) administered intervention program of electro acoustic music with embedded binaural beats to 169 patients at an emergency department and found their anxiety level to be reduced by 10%-15%. Sun and Sung (2013) posited that music with embedded binaural can both be beneficial in treating physiological and psychological problems. An example of psychological problem is anxiety, while heartbeat rate is physiological. In fact, when a person becomes anxious the heartbeat rate increases, as in the case of math anxious students. Wahbeh, Calabrese, and Zwickey (2007) conducted a pilot study in which participants listened to a CD with delta (0-4 HZ)

binaural beat frequencies daily for 60 days. Result revealed that anxiety decreased ($p = 0.004$).

Additionally, for this proposed project, the major supporting theoretical framework is the academic supporting theory to be employed as a teaching strategy of adult students (Svinicki, 2003). Specifically being applicable to introductory university/ college students as mentioned in section 1, it is imperative for students to improve their math performances and to be aware of their levels of math anxiety. Hence, the teaching style which is quite beneficial to this scenario is the social cognitive theory (SCT). In 1986 Albert Bandura proposed, SCT emphasizes more on the cognitive processes that occur while learning. Additionally, the Knowles' adult learning theory is considered in developing this project. In essence, there is an interconnection between the ways in which adults learn and the six principles of SCT. According to Svinicki (2003) the six SCT principles are: (1) information to be learned must be of importance to learners; (b) meaningful information is learned easier; (3) learners stored information in long-term memory in an organized format relative to their existing understanding of the world; (4) learners continually checked understanding, as such, resulting in refinement and revision of what is retained; (5) transfer of learning to a new context is not usually the norm, but can be attained through multiple applications; (6) learning is facilitated when learners become aware of their learning approaches and monitor their use.

Similarly, Knowles' five learning principles are: (1) adult learners are self-directed individuals; (2) adult learners use previous experience serves as a reservoir for learning; (3) adult learners demonstrate readiness to learn, particularly through

developing social tasks; (5) adult learners are problem-centered oriented than subject-centered; (5) adult learners are normally internally motivated to learn. From the above listing of the SCT and adult learning principles it is evident that learning is done uniquely. Hence, the instructional approaches must be specially designed to facilitate the introductory adult math students at the urban university. Finally, the attentional control theory (ACT), which confirms that anxiety hinders efficiency on tasks involving the inhibition function (Eysenck, Derakshan, Santos, & Calvo, 2007).

Relating to structural frameworks, recommendation relating to the mathematical incompetence of university students with math anxiety has been a call to action. In addition students provided feedback requesting more information, skills, and training on time management, instructional strategies, notes taking, motivation and attitude, and other ways of reducing anxiety.

Time Management

According to Balduf (2009), besides study skills, there are other aspects of students' experiences contributed to their college under achievement. One such aspect is poor time management. Similarly, at the urban university, there are many students who are math under achievers (i.e., gaining an average math score of less than 45%). In fact, in any subject that is mathematically oriented, some of these students are very fearful of participating in that subject. However, if students are more aware of the importance of being able to manage their study time effectively, then they could perform better at their test/exam. Jackson (2009) stated that realistic time management and organization plans

can improve one's output and hence life overall. Furthermore, she stated that the key elements of time management are goals, organization, delegation, and relaxation.

Besides, the perspective of effective teaching skills, high levels of student engagement is based on good classroom and time management skills (Jordon, Schwartz, & Mcghie-Richmond, 2009). Kirschner and Karpinski (2010) used a descriptive exploratory survey to demonstrate that FACEBOOK users reported that they received lower GPA and spend less time studying per week. So, in the case of working adult students studying at a university, in general, good time management is of paramount importance for academic success. In other cases, students are unable to plan their study time effective because formative feedback is not done in a timely manner. Locally, this is a noted problem in many instances, where students are not aware of in course test grades. According to Fluckiger, Vigil, Pasco, and Danielson (2010), formative feedback involving students as partners is the way forward to maintain the reciprocity between teaching and learning. Although, the aforementioned scenario is a reality in some university students' lives, they should further be aware of the relationship between homework activities and self-regulation processes (i.e., time management, goals, and self-directed attitudes). Evidence from experimental studies revealed that students can be trained to develop self-regulation skills while pursuing homework activities.

For example, by learning the foundational time management during law school, students have at least a strong chance of overcoming any hurdles that are set against time to practice (Bartholomew, 2013). Hong, Sas, and Sas (2009) deficient test-takers also need to be guided how to allocate and manage their study time wisely, to structure their

study environment to increase concentration and reduce distractions, as well as to develop self-directed and advocacy skills such as seeking additional help from instructors/teachers when needed. More so if the learner is a working adult student, because in many instances he/she has limited time for academics, particularly studying and time to practice especially conceptual modules like math. Loong (2013) posited that the Learning and Study Strategies Inventory (LASSI) was used to measure students' self-regulated learning strategies, in these subscales time management is very essential, especially at an institution where many foreign students attend. The results of statistical analysis revealed that international students scored significantly higher than home students in Anxiety, Self-Testing and Time Management subscales of the LASSI. This instrument could be quite useful to adult math students at the local level as well as for students studying at the university who are from overseas.

Instructional Strategies to Improve Math Performance

Instructional method is the specific activity in which the instructor and student will be involved during the lesson, which involves case-based, scenario, narrative-based, and problem-based instructions (Andrews, Hull & Danahue, 2009). Because schools are held accountable in providing high standards of education, it is important to focus on academics and the need for effective teaching practices (Vannest, Temple-Harvey & Mason, 2010). Slavin, Lake, and Groff (2010) concluded that programs that affect daily teaching practices and students' interactions are more impactful than those emphasizing textbooks or technology alone.

According to Lazakidou (2010), an instructional method based on Stemberg's model of problem within an authentic context consists of three main phases: observation, collaboration, and semi structured guidance. Because of the current semester system at many local universities this model approach is rarely applied in educational setting. However, based on feedback from the students at the urban university, this model would be very useful in particularly adult education settings. Indeed, it a useful way of reducing anxiety, which can only be very effective as a policy reform. Williams (2008) argued that today's schools face unprecedented challenges in preparing students for the unpredicted global workplace. As such, the student's ability to achieve academically is very essential. Particularly, math competence is of great significance for any student analytic and reasoning skills, therefore, basic computational skills are required in academics. Parkinson (2009) posited that supplemental instruction has long history and has been proven to be effective in the US. Parkinson carried out a carefully controlled study of the effects of peer assisted learning by first year students with first year students. At the start of the study, both tutored and non-tutored groups were evenly matched. However, after one semester of tutoring, the students' calculus test scores increases by approximately 13%. Rittle-Johnson and Koedinger (2009) carried out experimental studies with two grade six schools in the UK, with sample number, $n = 77$ and 22 respectively. In both experiments the researcher discovered that the students who exposed to iterative sequencing lessons gained more knowledge in arithmetic. Also, the students were able to transfer the procedures learned to problem in novel settings. In this scenario, students could make clearer connection with the math concepts and their applicability.

According to Montague, Krawec, Enders, and Dietz (2014), results of the Bayesian analyses indicated that the (solve-it) instructional intervention of a cognitive intervention strategy was somewhat stronger for low-achieving mathematics students than for average-achieving students from a group of grade seven (n =1059) of 40 middle schools in a large urban district in USA. That is, 644 in the research-based cognitive intervention strategy group and 415 in the comparison group. Overall, the intervention program was effective for the varying ability groups and is quite appropriate for students with varied math abilities.

Akinsola and Frederick-Jonah (2014) used ANCOVA statistics analysis in a pretest-posttest control group quasi-experimental design, that is, 344 pupils from 12 public primary schools in Nigeria. The results revealed that students exposed to game and poem enhanced instruction intervention (i.e., treatment group) have better mean achievement score than the control group. But game was found to be more effective in improving pupils' mathematics achievement than poem.

A study (which investigated the effects of self and cooperative learning strategies on secondary student's attitude towards math) adopted pre-test and post-test, control group quasi-experimental design using a 3 ×2 ×2 factorial matrix with two experimental groups and one control group, with sample number 350 from six purposefully selected secondary schools in Ogun State. Analysis of Covariance (ANCOVA) and Scheffé *post hoc* analysis were the statistical procedures used for data analysis. Analyses revealed that math teachers should be trained to use self and cooperative learning packages in the math

classroom, because these strategies impact students' math attitudes positively (Mohammad-Hassan, Farhad, & Nasrin, 2014).

Finally, in a 3-year randomized control study discovered that over time coaches positively affected student achievement in Grades3, 4, and 5. In this scenario, this significant positive effect on student achievement was not evident at the end of the first year of placement of a coach in a school, but emerged as knowledgeable coaches gained experience and as the stakeholders at the school worked collaboratively (Campbell & Malkus, 2011).

The above math interventions/ instructional approaches in the math classroom provide insights for possible strategies that could be used to improve mathematics instruction at the local level. Indeed, sometimes educators will have to think out of the box to maintain the reciprocity between teaching and learning. The results relating to students' math and anxiety tests supported this notion, because a novel interventional project of anxiety reduction produced significant *p*-values.

Notes Taking

Classroom settings have changed a lot, particularly, with the advent of computer and technology. In a recent research, a lecture was done by a professor in person in 20 minutes, during this time the students took notes. Subsequently, the same lecture, was given by a podcast, during the podcast delivery the students took notes. The findings revealed that those students who took notes while listening to the podcast scored significantly higher (Mckinney, Dyck, & Luber, 2009). So, not only are note taking important, but also clarity one gets when writing the notes. Brazeau (2009) notes that

notes taking facilitates active learning, but this can hampered when students are given lots of handouts, because students would not be involve in the process of identifying, collecting and organizing information.

In recent times computer technology enables notes takers to perform better on immediate test, and also they will retain the information better thus they will perform much better in delayed test of one week later (Beck, Hartley, Hustedde, & Felsberg, 2014). However, Mueller and Oppenheimer (2014) argued that taking notes with the hand is much better to do when the learner is required to recall numerous amounts of concepts. In the case of mathematics, most students who take notes in the face-to-face lectures perform better in math tests. Correlational analyses of data from three experiments of different ways to taking notes revealed that for those who took notes in an organized fashion, working memory predicted note-quantity, which predicted recall on both immediate and delayed tests (Bui, Myerson, & Hale, 2013). Hence the variable of test performance can be predicted from these predictor variables. In this case, multiple regression analysis is most suitable. In the qualitative settings, notes taking of written note, videotaping, and tape recording forms mostly use, Muswazi and Nhamo (2013) concluded that once permission is given, videotaping is the best form of notes taking. All in all, the studies reviewed revealed that for quantitative classroom settings the hand written form of taking notes would impact students test scores positively.

Motivation and Attitude

Papastergiou (2009) revealed that educational computer games can be exploited as effective and motivational learning environments, despite gender difference. In this

case, a sample of 88 Greek students did a pre-and posttest. Also, feedback of students' questionnaires supported the computer gaming approach. Cleary and Chen (2009) in a study of 880 suburban middle school students, the analysis of variance was utilized for the group differences in student self-regulation and motivation. Also, the linear regression was used to depict variables that best predicted students' use of regulatory/motivational strategy. A finding from the study revealed that achievers (i.e., those satisfactory academic performances) were more motivated. Students drive their own learning when they are involved in project based learning (PBL), this is the learning approach to develop critical thinking strategies in the 21st century (Bell, 2010). Additionally, with the usage of computer and technology students can be more motivated to work much harder to overcome mathematical and other educational challenges. A study of 1,719 Portuguese students, of fifth-to-twelve graders in a hierarchical analysis using equation modeling showed that motivation-related variables are the main predictors of attitudes towards math (Mata, Monteiro, & Peixoto, 2012).

Likewise teachers and social support of peers are crucial in understanding these attitudes (Mata, Monteiro, & Peixoto, 2012). According to Kalder and Lesiki (2011), recommendations in exposing pre-service teachers to positive attitudes and beliefs about math are essential for students in the math classroom. If this attitude is not displayed in the classroom by teachers then students will not develop good attitudes for the subject. Mohamed and Waheed (2011) showed a sample of 200 secondary students completed questionnaires to find out their math attitudes, the questions were based on personal confidence, perceived usefulness of the subject. The results showed that the students' had

average attitude, but there was no gender difference in their attitudes. Adeyinda and Kaino (2012) demonstrated in an analysis that math achievement at the senior secondary school level in Bostswana was significantly influenced by positive attitude. Lazarides and Ittel (2012) examined a sample of 361 students in grades 8, 9, 10 (41.3% female) attending ten public schools located in Berlin, Germany. Findings revealed a positive effect of perceived parental school support on students' interest. However, there was a negative effect of perceived teacher support on students' grades. Gender differences did not differ for ethnic groups but attitudes were strong predictors of math achievement, which was consistent with hypotheses (Else-Quest, Mineo, & Higgins, 2013).

Furthermore, at the higher education level of graduate and undergraduate students (N = 384) who completed the Index of Learning Styles and Attitudes Towards Mathematics Inventory and findings suggested that STEM majors have more positive attitudes toward mathematics, while gender and race do influence both learning styles preference and attitudes toward mathematics (Middleton, Ricks, Wright, & Grant, 2013). It is believed that the teacher attitude toward math impacts the students' attitudes of math and ultimately the students' performances. For example, in a sample of 100 students and four math teachers making a total of 104 respondents, the students were randomly sampled while the teachers were purposefully sampled. Questionnaire data and end of term exam were used as the measures. It was then revealed a significant relationship between teacher attitude and student attitude toward mathematics. Therefore, the positive teacher enabled positive students, which was demonstrated in the students' exam scores (Mensah, Okyere, & Kuranchie, 2013).

Other Ways of Reducing Math Anxiety

Math anxiety can be reduced three different ways, which include: Curricular, instructional, and non-instructional (Iossi, 2007). In adult education curriculum, an audience response system (ARS) allows students to respond to multiple choice questions using a remote control device. The responses are instantly displayed in a chart form and are then discussed by the instructor and the class (Kay & LeSage, 2009). In this scenario, students who are not very confident in working a math question can also participate by using the remote system. From an instructional point of view, a cooperative learning group can drastically reduce chemistry anxiety. In a quasi-experimental design that took place in senior secondary schools in South-West Nigeria, for example. 120 students were randomly selected into two groups. The groups were cooperative learning and conventional method (i.e., chalk-and-talk), which were both pretested in chemistry. At this stage both groups demonstrated a high level of understanding for the subject. However, after the post-testing, the participants in the cooperative learning group had their chemistry anxiety reduced significantly (Oludipe & Awokoy, 2010).

Gresham (2009) found a negative correlation, r = -0.475 for a group (n = 156) of pre-service math teacher efficacy and math anxiety in elementary teachers. Hence, a way to reduce that high level of math anxiety in pre-service teaching is to introduce staff training programs to boost their self-efficacy. Students (N= 80) varying in math anxiety were asked to sit quietly (control group) prior to completing difficulty-matched math and worded algebraic problems or to write and express their thoughts and feelings regarding the exam they were about to take (expressive writing group. The results have shown that

the writing group did significantly better than the control group. In essence, writing did reduce anxiety prior to the test experience (Park, Ramirez, & Beilock, 2014).

Cognitive-Restructuring treatment (i.e., is the training of students to develop thinking pattern or perceptions, that is, to use desensitization techniques) a strategy to reduce anxiety in Mathematics (Asikhia, 2014). A 2 x 2 x 3 pre-test, post-test factorial design (treatment, gender, and study habit) was used in the study, the sample being mathematics anxious students who were randomly assigned to one experimental group and one control group of 90 males and 90 females respectively. A greater interference effect was found for response times (ERP's) in the 17 high math anxiety (HMA) group than in the 17 low math anxiety (LMA) one. In this scenario, math anxiety is related to a reactive and compensatory recruitment of control resources that is implemented only when previously exposed to a stimuli presenting conflicting information. That is, congruency reduces the math anxiety behavior/cognitive positively (Suárez-Pellicioni, Núñez-Peña, & Colomé, 2014).It is important to note the results of more studies should to be taken from both the teachers' views and also the need to look at pupils' views to get deeper understanding of the information about the topic and to structure the ways of reducing anxiety in mathematics based on views of both sides (Alkan, 2013). However, the results of this project study were taken from the analysis (researcher's view) and the views of math students' on math anxiety reduction in the math lab.

Implementation

Because the project study is considered to be a pilot study, therefore the implementation stages would be as follows. (1) The findings of the study would be

presented in a brief and comprehensive manner. (2) The study would be done on a larger scale. (3) Different instructional approaches to be explored as recommended based on feedback provided on questionnaire. The head of school, dean of faculty, and the instructors would be presented with details of the aforementioned. Subsequently, I would plan to replicate the research with a larger sample. This would facilitate generalization to a larger population. In doing this, more persons would become aware of the problem. With a larger sample, the Minister of Education would be convinced that the problem needs immediate attention, if in fact the findings could be replicated.

Potential Resources and Existing Supports

Electrical components, namely: headphone preamplifier, 2 laptops, (30-40) feet length conductor wire, 2 EEG equipment, headphone plug in boxes, other electrical fittings, and headphone input boxes. Currently, $500,000.00 is allocated as a grant. This sum of money is available for research based projects being conducted by one researcher. However, if two persons collaborate the assessable sum would be $1,000,000.00

Potential Barriers

Below are some factors that impacted this research project. First, perhaps, research studies conducted properly are time consuming. It would be recommended that other doctoral students interested in conducting research further could be made aware of this pilot study. Second, adult students will have limited time to spend in math lab for treatment sessions. Therefore, future researchers should be made aware of this fact. Hopefully, arrangements can be made for adults to access the treatment at home through online availability. Additionally, research could also be conducted with traditionally aged

students. Third, there was an attrition rate of students due to a deregistration system for late fees payment. This researcher is not sure what to do about this issue.

Proposal for Implementation and Timetable

Implementing this educational reform policy (i.e., given consideration to reduce students' math anxiety) requires organizations to implement change in order to correct student's math anxiety and improve math competence. This policy is pertinent because of the high failure rate in precalculus math and generally poor math competency skills. Consequently, the Dean of FOSS will be consulted to inform the respective heads of departments and committees. In this case, majority of the instructors and students will be informed about the policy to be drafted into the university's curriculum. That is, the feedback on the questionnaire items, particularly, time management and instructional approaches. As such, beneficiaries will never feel as if they treated with favoritism or unfairly. This policy recommendation for the proposed project will be effective at the beginning of each semester and runs for the entire 13-week semester. In the six to seven week the proposed project's treatment will be administered to experimental treatment group. Subsequently, the controlled group will receive experimental treatment.

Roles and Responsibilities of Student and Others

The stakeholders to be involved with the policy recommendation are: the Dean of FOSS, Heads of divisions/committees, instructors, and students. The role of each person will be listed as follows. First, the role of the dean is to inform the recommended policy major role of instructors. Second, heads of divisions to inform workers. Third, the instructors will inform students and provide them with brochures of the proposed project.

Finally, students will be the recipient of the proposed project to reduce math anxiety; hence the students' math test scores will be improved.

Project Evaluation

For this project, goals-based and progress-based evaluations will be used as assessment tools. This approach is important due to decreasing funds and increasing stakeholders calls for improvement of students' performances in math all levels in Jamaican schools. There is the need to measure the effectiveness of projects. This approach will allow the stakeholders to measure whether, and how projects make real difference in the lives of students may be evaluated. In doing these evaluations, light will be shed on what works and what needs amendment. Hence positive social change can be fostered.

Implications Including Social Change

Local Community

In fostering positive social change, this project will be addressing the needs of learners in my local community, by impacting positively greater awareness and treating math anxiety. The effect of reducing math anxiety will improve students' math test score. In this case, students, families, instructors, administrators, and community partners will be beneficiaries by sustaining this project.

Far-Reaching

I have developed a website which provides information about math anxiety and its treatment for introductory math students (i.e.,www.themusicofmath.com). Since math incompetence has been a major concern to stakeholders globally, Mbugua, Kibet, Mutha,

and Nkonke (2012) revealed that math performance by students has continuously been poor in secondary schools in Kenya. Hence, creating a website, other educators and students can gain access to this website through internet availability. Particularly, students and educators will both gain knowledge of identifying and treating math anxiety, therefore improving math test scores.

Conclusion

In summary, the description and goals, literature review, rationale, and implication to impact social change are great importance. But, most importantly is the ability for the practitioner to initiate the process, therefore, call to action, implement, and sustain the project are pertinent. Although, this can be a great challenge, the goals of the project can only be attained, if the stakeholders work in great collaboration both locally and internationally for greater good. This collaboration can be maintained with the advent of computer and other technologies, as a way forward. Lastly, recommendations will be made for students who are severely mathematical anxious to see the mental health practitioner.

Section 4: Reflections and Conclusions

Introduction

The reflections I had of this research study positioned me to understand the quality of time required to craft a research topic and then to see the different stages the research study has to undergo before the results of the research can be presented and disseminated to the consumers of research. Despite the rigor of the processes, academic integrity was always upheld. Therefore objectivity was maintained throughout the secondary data analyses. Finally, the ethical issues concerning the students were highly considered because of the wait-control design. In this case, both treatment and controlled groups both benefitted from the research study.

Project Strengths

Some the strengths of this project were that (a) objectivity was maintained throughout research study; (b) it could have possible national impact, with a larger sample size, because of the minister of education's involvement; (c) many introductory students entering the university can be helped with this project; (c) the possibility of replication can be easily attained from copyrights owners; and (d) the reduction of math anxiety can be easily administered. Hence, the national math crisis that affects the local area can be addressed.

Recommendations for Remediation of Limitations

Possible ways to remediating the project's limitations were as follows: (a) minimizing the attrition rate of students, because of deregistration process; (b) using a greater sample size to ensure generalization; (c) the unconventional research study would

need great media publication for stakeholders to support the project. As a result, special meetings will be arranged with the ministry of education and dean of FOSS. In addition, promotion through television and radio would foster a national education program on the topic of math anxiety and ways of reducing it. Otherwise, school-to-school visits could be done to inform local educators about the math anxiety problem. Then an online correspondence could be set up with the schools where students are very mathematically anxious.

Scholarship

Scholarship is twofold. First, it refers to a grant which is given to an individual who demonstrates excellence. Second, scholarship expresses the high level of academic standards attained by a person. For the second case, this person must go through many stages, during which he or she must review, critique, synthesize, and reflect during scholarly writing. Additionally, many reviews must be done at many different stages by independent organizations or committees before approval is granted to the budding scholar practitioner.

Project Development and Evaluation

I have learned that in order to develop a project, an individual must be passionate about project management, that is, to plan, organize, and implement at the different stages that are required to acquire an effective product. Without evaluation an individual will not know what works and what does not. The best way to do this is seek feedback from those persons who have participated in a task.

Leadership and Change

One person with an idea can initiate a process of social influence by enabling the support of others in accomplishing a common task. By accomplishing this common task, a change can be made possible. Often times, it is through this change, peoples' lives are impacted positively, both locally and internationally.

Analysis of Self as Scholar

In accomplishing this common task, one must be focused; this approach delimited the area of inquiry in which I am working as a math educator. Hence, many possibilities were considered to select the most appropriate decision.

Analysis of Self as Practitioner

Being an educator for the past 20 years in the field of math education, I have gained mathematical experience. From the experience gained, I am now better able to integrate theory and practice through critical thinking, particularly through online weekly discussions with colleagues of different ethnicities and experiences during my EdD discourse. Of course, this weekly continuous process fostered practitioners in various educational fields.

Analysis of Self as Project Developer

In order to be developed as a practitioner, projects must be developed, which requires determination, devotion, and discipline. Additionally, one has to be constantly thinking in a very critical fashion to address social and other issues by implementing and sustaining projects.

The Project's Potential Impact on Social Change

This project of math anxiety reduction has the potential of helping students locally and internationally because it can be administered online. In fact, there is a website named www.themusicofmath.com that was designed to address students' math anxiety problems. As the results of the research indicated, after treatment the students' math test scores increased. Additionally, the students' math anxiety was decreased. These two findings will be reported to the minister of education and the dean of FOSS. In this case, greater awareness and possible treatment of math anxiety will be promoted.

Implications, Applications, and Directions for Future Research

This project study will be made available at many local universities. This will enable future doctoral students to replicate the research study. During these studies, many students who are math anxious will be surveyed and treat their levels of anxiety. In doing this, many more educators will do more research in this area to address the global math crisis.

Conclusion

As summary, being a budding scholar practitioner, I will share and apply the knowledge I have gained during my study to impact stakeholders in the field of math education. It is hoped that both local and international persons will be impacted positively. This will be made possible through the collaboration of professionals in the field of math education. In fact, with the advent of modern technologies, dialogues of educators through teleconferencing will be ongoing. As such, the aforementioned objectives and goals of the project will be attained in the future.

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Appendix A: Policy Evaluation

Introduction

From the findings of the research, the project was crafted to address two overarching issues: (a) reduction of math anxiety; (b) suggestive ways of reducing high math failure rate proposed by students based on data from a questionnaire. Finally, this project (i.e., Reducing Math Anxiety through Musical Instrumental Tones" (RMATMIT) is intended to provide information to the key stakeholders (i.e., the Minister of Education) and Dean of Faculty of Science and Sport (FOSS).

Description and Goals

This project genre is a policy evaluation that will provide a statement of the problem of low math scores and high math anxiety at the local level, the need for the study that was conducted as a result of identifying the need, the results of the study that was conducted, feedback from the students participating in the study, and implications for further research. Implications for further research include both further research with regard to binaural beats/isochronic tones and further research and a proposed action plan regarding mathematics preparation.

Also described will be implications of the research to the great community and key stakeholders which include an awareness through policy recommendations of (a) beats/tones/music that can reduce math/test anxiety at an urban local university, (b) the ways of improving low level of mathematical skills/competency, (c) the importance of reducing of math/test anxiety at the university level to stakeholders (minister of education, dean of faculty, parents and students) through appropriate teaching and

learning style. The policy recommendation will be based on the findings from a recent research study entitled, “Intervention Program Data for Reducing Math Anxiety Fostering Positive Social Change” (Pinnock, 2014). Furthermore, in spite of the intervention, findings revealed that math skills are still low. Thus, stakeholders would be fully aware that more needs to be done to address the major concerns about the university precalculus students’ challenges, which include, but may not be limited to providing further support and instruction in the areas of time management, math performance and skill building, note taking, math motivation and a positive attitude, and other ways of reducing math anxiety that include curricular, instructional, and non-instructional approaches.

At a small urban university where I work as a lecturer of physics/math, the introductory math courses (i.e., college algebra and precalculus) show a high math failure rate. It has been assumed and later hypothesized from section 1, that the high failure rate is as a result of math anxiety affecting the students. The need for this math crisis to be addressed is national importance, because the international monetary fund has been made available to Jamaica under certain condition, that is, there should be reduction in public sector non-technical workers. As a result, the Chinese government will be collaborating with the Jamaican government to establish a high technology transshipment hub, where thousands of workers will be employed. As such, only mostly qualified technical persons will be employed (i.e., those with good math background). This local affinity for math has been reflecting from the results from a recent research study.

The purpose of the quantitative research study was to examine whether math anxiety can be treated through isochronic tones. With better math performance at the university level, it is predicted that more students can get jobs in technical or professional fields. In this secondary analysis of data based on a pre–and posttest wait-control group design conducted by the mathematics department at a small urban university in Jamaica, two groups (i.e., $n = 48$) of introductory precalculus, math students displaying different levels of math anxiety were treated in 18 ten-minute sessions with isochronic tones. The study investigated differences between two groups (i.e., a control and an experimental group) of students with math anxiety, one, treated with brain waves entrainment intervention for that anxiety with the second group working on math tutorial questions. The researcher tested the following hypotheses: (a) Math anxiety is negatively correlated to students' pre-math tests scores; (b) isochronic tones will impact students' posttest math anxiety as measured by Suinn and Winston math anxiety test and math scores as measured by standardized math test. The findings revealed that the treatment works. First, a correlation coefficient of $r(46) = -0.39$ which was significant at the 0.002 level for pre-math test and pre-anxiety. Second, the mean difference between groups 1 and 2 on math measures favoring the treatment group was statistically significant at the specified .001 level, $t(44.49) = 3.99$, $p < .000$, $d = 0.25$, 95% CI [11.39, 34.68]. Third, for post math anxiety, the mean difference between groups 1 and 2 was statistically significant at the specified 0.05 level, $t(38.9) = 2.42$, $p < .02$, $d = 0.70$, 95% CI [2.51, 27.86] favoring the treatment group. Thus, the treatment was found in this study to reduce both math anxiety and improve students' math test scores. This study impacted positive social change by

helping to provide a mathematics test taking experience for students locally, that is, less anxiety producing and more positive in terms of mathematics outcomes. Although p-values for the hypotheses were significant in the research study, far more research is needed in this area.

Additionally, feedback from the students on a self-developed, single-ended questionnaire with six items (i.e., in Table 8) has shown that it is important to improve their math basic competence. In fact, they have indicated that any additional help to improve math skills is highly appreciated. It is pertinent for students to improve math competence, indeed, this would have positive implications in the workplace, that is, (a) more Jamaicans could be employed in areas that are normally occupied by foreigners, (b) the GDP could be increased, (c) reduction of crime and violence; because more persons could be employed, (d) obviously, the sample number is small, so in the near future a larger sample will be randomly selected for the next research study, this enable generalization to be done. Overall, the goals of this project are as follows:

1. To bring about positive change in math learning and teaching in order to positively impact unemployment
2. To create a national awareness of math anxiety and ways of reduction via online access to website.
3. Recommendations to implement new instructional approaches, curriculum strategies, and a more student-centered approach to mathematics education.
4. Initiating the platform for more research studies to be done in this area.

Rationale

This project was chosen because many instructors complained about the incompetency of their students in doing basic math tasks, which was reflected in a high failure rate in math. Additionally, with better math competency students can take up job offers in technical mathematical and scientific areas, because of the current scarcity of employment globally. In order to address the aforementioned local issues, the author designed doctoral research study to address these issues. The number of students that were considered for this project was 48. This number was appropriate for the research study. As a result, the t-test was employed for data analysis because the t-test can be applied to a sample number of 30 participants. The other analysis that was used is the Pearson correlation which was appropriate because all the students' data was collected in each lab session. In the math lab, the design of the instrumental isochronic tones apparatus enabled all the students to receive treatment via headphones at the same time. By administering the treatment to the students in this manner and in analyzing the data, the extent of the reduction of students' math anxiety after the post tests are administered will be shared with stakeholders. Further, recommendation/s based on the research will be made to the respective stakeholders. It is hoped the students' math anxiety can be identified and treated in local schools after further research is conducted. It takes persons with authority to enact curriculum and instructional changes in terms of educational reform.

Review of the Literature

Analysis of Research and Theory about Project Genre

In order to access the articles for this literature review selective online search of the database from Google, Scholar, Google, and Walden library current journal peer reviewed articles was conducted. The searching process was done by Boolean searching method (i.e., NOT, AND, OR selections and a combination of AND-OR and OR-OR). The key words that were used are: math anxiety, math achievement, math instruction, music psychology, learning methods in mathematics

The project to be analyzed is the policy evaluation in the field of education. Some of the major structural theories underpinning this project genre are: (a) game theory, (b) backward inductive theory, (c) Kingdon's (1995) agenda-setting theory. This theory states that agenda setting is the first stage in the policy. Although game theory is highly applicable in field of math, it is quite applicable to psychologists in the field of social science. Game theory was first introduced in 1944 by John Von Neumann. This theory states that one player's ability to win a game is critically dependent on the inputs of the other players. From game theory, the backward design is evolved. Backward design is to consider program/project outcomes at the start of the conceptualization process. These theories will be able to guide and shed light on the development of this proposed project. According to Vella (2009), it is very important to consider the outcome of a project/program before it commences. Also, Daffron (2008) stated that the project outcomes are assessed at the end of the project, while the objectives are benchmarks to be

achieved during the project, which are listed in the above in the rationale. These outcomes are aligned to the mission statement (which is a form of management theory) of local university which is to provide educational opportunities, research, and consultancy in science and technology in order to advance industries, health care, and business (Utech, Purpose and Objectives of Faculty, 2009). Additionally, the Minister of Education mission statement is to provide strategic leadership and policy direction for quality education for all Jamaicans to maximize their potential, contribute to national development and complete effectively in the global economy. It is hoped that problem of this project study can be addressed by upholding the fundamental principles of the urban university and the Ministry of Education through policy evaluation.

A policy evaluation is a systematic process for assessing the design, implementation, and outcomes of public policies (Anderson, 1994). Two main types of policy evaluation are formative and summative evaluation. Evaluation is done in social science research approaches, including qualitative and quantitative techniques to examine the effectiveness of policies. Below is a discussion of research-based analyses, interconnection between analyses and content of project which is math anxiety reduction, and hence improving math scores through proper management of time, improving math attitude, motivational coaching, and learning study skills.

In this evaluation the analysis of posttest outcomes on an algebra proficiency exam finds no effects in the first year of implementation, but finds evidence in support of positive effects in the second year. That is, for most mathematical instructions the teaching outcomes are noticeable over few years. The estimated effect of the algebra

course is statistically significant for high schools but not for middle schools. Nevertheless, in both cases, the magnitude of the positive teaching impact is enough to improve the median student's performance by an eight percentile points (Pane, Griffin, McCaffrey, & Karam, 2014). Moss, Yeaton, and LIoyd (2014) conducted parametric and nonparametric analyses on a sample of 2122 at a large Midwestern College for the teaching of developing mathematics, yielding increases that generally ranged from one quarter to one third of a grade point, for a 1 to 4 grade scale. The within-study findings from the randomized experiment (RE) further established the credibility of regression discontinuity (RD) to produce unbiased estimates. Implications of additional validity threats were considered to be eliminated in this embedded design, that is, (R-RE-D). In order to ensure that student's graduation rate does not lag behind students' attendance rate it is imperative that the university facilitate coaching sessions. The coach normally contacts students regularly to develop a clear vision of their goals/objectives, to guide them in connecting their daily activities to their long-term goals, and to support them in building skills, including time management, self-advocacy, and study skills. In essence, coaching is more cost effective to reduce attrition rate rather than other financial aid interventions (Bettinger & Baker, 2014). Coaching would be a math support system to be introduced at the urban university in Jamaica, because it could help the poor performing students to receive better grades in mathematics in their math tests.

Jacob, Goddard, and Kim (2014) posited that public use of aggregate data is sufficient and appropriate (a) when means and standard errors differ between models that use individual student-level data and those that use aggregate school-level data, (b) the

potential for conducting subgroup and non-experimental analyses with aggregate data, and (c) the metrics that are currently available in state public-use data sets and the implications these have for analyses. In fact, these metrics can suffice quantitative evaluations for non-experimental research.

It is evident from the above policy evaluation analyses that the methods used in evaluations, including regression models, pre-test and post-test experimental designs, estimation of means, and nonparametric approaches, are similar to analyses techniques used in this project study. This explains that the analytical approach and results obtained from the secondary data analyses used in this study are appropriately aligned to address the research questions posed in Chapter 1.

Analysis of How Research and Theory Support Project

Intervention theory is used in social studies and social policy refers to intervening effectively in a situation in order to secure desired outcomes. Advancing cognitive science requires a good understanding of how interventions are informed by, and test, theory (Michie, 2010), the findings of the project study revealed that math anxiety is evident among 70% of the introductory university students that were studied. Specifically, the research hypothesis in this project study has shown that math anxiety is negatively correlated to students test scores. Berger and Calabrese (1974) introduced the uncertainty reduction theory (URT). This theory is based on the human's thought process and their social implications. Surawy, Mcmanus, Muse, and Williams (2014) posited that mindfulness –based cognitive therapy (MBCT), could be used as an alternative method in

treating peoples' anxiety issues. And depending on severity of math anxiety, it may be appropriate to refer students to a mental health professional to them with anxiety.

Further Research of Beats to Reduce Anxiety

Thorn-well, Cannistraci, Anderson, Kim, Eapen, Gore, Blake and Dyken (2014) argued that neuron development disorder can be treated with musical sound as an external stimulus. Similarly the results of this project study provided exploratory data analyses to verify this musical response phenomenon. As discussed in section 2, math anxiety students normally experience an increase in heat rate whenever they are performing math related learning activities. In a survey of 36 randomly selected students, these students assigned to two groups. One the group listened to a fast tempo song and the other group listened to a slow tempo song. Results has shown that the students who listened the slower song for a 2.5 minutes period had their heat rate decreased after a one minute interval of time after listening to the song (Agrawal, Makhijani, & Valentiti, 2013).

In essence, beats/tones could be employed to reduce math anxiety, as was demonstrated in the math lab. In the math lab the laboratory technician uses isochronic tones to stimulate the neurons of the brain, which is actually the brain wave entrainment. The findings of this project study confirmed that some students' anxiety level was reduced significantly. Similarly, in another recently published study, a magnetoenhalogram was used to identify high-gamma waves of frequency (52 –100Hz) in a sample of 41 elderly participants who demonstrated that the attentional process in a

3-stimulus of oddball task differ in their cognitive age (Akimoto et al., 2014).In this case, brainwaves entrainment done by faster vibrational frequency might reduce anxiety quicker. Finally, the notion of hierarchically organized acoustic detection arrangement (i.e., prime tone frequency of 250 to 276 Hz between the ears to produce the perceived deviant-beat) can be used to replace the classical binaural beats entrainment, which are waves with slightly different frequencies being superimposed on each other (Chakalov, Paraskevopoulos, Wollbrink, & Pantev, 2014). A 64-channel and a dichotic listening task in 25 participants demonstrated neurophysiological mechanisms in conscious audio perception. This was identified within the gamma-band range during interhemispherical synchronization within the auditory cortices CSteinmann, Leicht, Ertl**,** Andreou, Polomac, Westerhausen, Friederici, & Mulert, 2014). Usually, beta stimulation (i.e., neurons vibrating with 16 to 45Hz) enables the beta waves entrainment which is essential for problem solving and reasoning skills development. Since gamma stimulation is approximately 50 to 100Hz, stimulating it could improve students'math test scores. Hence, a higher mean math score could be reflected in the findings of the project study.

The listening of beats/tones is two-fold. First, Russio, di Bernardo, and Sontag (2010) argued that entrainment to periodic inputs/stimulus will cause the timing and sequencing of reactions. Similarly, in the case of sound waves being listened to by a person, the neurons of the brain will move at a frequency similar to the frequency of the periodic sound waves. Second, in psychodynamic theory a person experiences unconscious internal forces, which causes both emotional and physical reactions. As such, students who are test anxious should be treated in therapeutic treatment sessions.

Similar to isochronic tones, which are filtered binaural beats used as the intervention program some further research are recommended, these include: One major treatment is through relaxation. Weiland et al., (2010), administered intervention program of electro acoustic music with embedded binaural beats to 169 patients at an emergency department and found their anxiety level to be reduced by 10%-15%. Sun and Sung (2013) posited that music with embedded binaural can both be beneficial in treating physiological and psychological problems. An example of psychological problem is anxiety, while heartbeat rate is physiological. In fact, when a person becomes anxious the heartbeat rate increases, as in the case of math anxious students. Wahbeh, Calabrese, and Zwickey (2007) conducted a pilot study in which participants listened to a CD with delta (0-4 HZ) binaural beat frequencies daily for 60 days. Result revealed that anxiety decreased (p =0.004).

Additionally, for this proposed project, the major supporting theoretical framework is the academic supporting theory to be employed as a teaching strategy of adult students (Svinicki, 2003). Specifically being applicable to introductory university/ college students as mentioned in section 1, it is imperative for students to improve their math performances and to be aware of their levels of math anxiety. Hence, the teaching style which is quite beneficial to this scenario is the social cognitive theory (SCT). In 1986 Albert Bandura proposed, SCT emphasizes more on the cognitive processes that occur while learning. Additionally, the Knowles' adult learning theory is considered in developing this project. In essence, there is an interconnection between the ways in which adults learn and the six principles of SCT. According to Svinicki (2003) the six SCT

principles are: (1) information to be learned must be of importance to learners; (b) meaningful information is learned easier; (3) learners stored information in long-term memory in an organized format relative to their existing understanding of the world; (4) learners continually checked understanding, assuch, resulting in refinement and revision of what is retained; (5) transfer of learning to a new context is not usually the norm, but can be attained through multiple applications; (6) learning is facilitated when learners become aware of their learning approaches and monitor their use.

Similarly, Knowles (1970, as cited in Merriam, Caffarella, & Baumgartner, 2004) the five adult learning principles are: (1) adult learners are self-directed individuals; (2) adult learners use previous experience serves as a reservoir for learning; (3) adult learners demonstrate readiness to learn, particularly through developing social tasks; (5) adult learners are problem-centered oriented than subject-centered; (5) adult learners are normally internally motivated to learn. From the above listing of the SCT and adult learning principles it is evident that learning is done uniquely. Hence, the instructional approaches must be specially designed to facilitate the introductory adult math students at the urban university. Finally, the attentional control theory (ACT), which confirms that anxiety hinders efficiency on tasks involving the inhibition function (Eysenck, Derakshan, Santos, & Calvo, 2007, as cited in Erakshan, N., Smyth, S., & Eysenck. 2009).

Relating to structural frameworks, recommendation relating to the mathematical incompetence of university students with math anxiety has been a call to action. In addition students provided feedback requesting more information, skills, and training on

time management, instructional strategies, notes taking, motivation and attitude, and other ways of reducing anxiety.

Time Management

According to Balduf (2009), besides study skills, there are other aspects of students' experiences contributed to their college under achievement. One such aspect is poor time management. Similarly, at the urban university, there are many students who are math under achievers (i.e., gaining an average math score of less than 45%). In fact, in any subject that is mathematically oriented, some of these students are very fearful of participating in that subject. However, if students are more aware of the importance of being able to manage their study time effectively, then they could perform better at their test/exam. Jackson (2009) stated that realistic time management and organization plans can improve one's output and hence life overall. Furthermore, she stated that the key elements of time management are goals, organization, delegation, and relaxation.

Besides, the perspective of effective teaching skills, high levels of student engagement is based on good classroom and time management skills (Jordon, Schwartz, & Mcghie-Richmond, 2009). Kirschner and Karpinski (2010) used a descriptive exploratory survey to demonstrate that FACEBOOK users reported that they received lower GPA and spend less time studying per week. So, in the case of working adult students studying at a university, in general, good time management is of paramount importance for academic success. In other cases, students are unable to plan their study time effective because formative feedback is not done in a timely manner. Locally, this is a noted problem in many instances, where students are not aware of in course test grades.

According to Fluckiger, Vigil, Pasco, and Danielson (2010), formative feedback involving students as partners is the way forward to maintain the reciprocity between teaching and learning. Although, the aforementioned scenario is a reality in some university students' lives, they should further be aware of the relationship between homework activities and self-regulation processes (i.e., time management, goals, and self-directed attitudes). Evidence from experimental studies revealed that students can be trained to develop self-regulation skills while pursuing homework activities.

For example, by learning the foundational time management during law school, students have at least a strong chance of overcoming any hurdles that are set against time to practice (Bartholomew, 2013). Hong, Sas, and Sas (2009) deficient test-takers also need to be guided how to allocate and manage their study time wisely, to structure their study environment to increase concentration and reduce distractions, as well as to develop self-directed and advocacy skills such as seeking additional help from instructors/teachers when needed. More so if the learner is a working adult student, because in many instances he/she has limited time for academics, particularly studying and time to practice especially conceptual modules like math. Loong (2013) posited that the Learning and Study Strategies Inventory (LASSI) was used to measure students' self-regulated learning strategies, in these subscales time management is very essential, especially at an institution where many foreign students attend. The results of statistical analysis revealed that international students scored significantly higher than home students in Anxiety, Self-Testing and Time Management subscales of the LASSI. This

instrument could be quite useful to adult math students at the local level as well as for students studying at the university who are from overseas.

Instructional Strategies to Improve Math Performance

Instructional method is the specific activity in which the instructor and student will be involved during the lesson, which involves case-based, scenario, narrative-based, and problem-based instructions (Andrews, Hull & Danahue, 2009). Because schools are held accountable in providing high standards of education, it is important to focus on academics and the need for effective teaching practices (Vannest, Temple-Harvey & Mason, 2010). Slavin, Lake, and Groff (2010) concluded that programs that affect daily teaching practices and students' interactions are more impactful than those emphasizing textbooks or technology alone.

According to Lazakidou (2010), an instructional method based on Stemberg's model of problem within an authentic context consists of three main phases: observation, collaboration, and semi structured guidance. Because of the current semester system at many local universities this model approach is rarely applied in educational setting. However, based on feedback from the students at the urban university, this model would be very useful in particularly adult education settings. Indeed, it a useful way of reducing anxiety, which can only be very effective as a policy reform. Williams (2008) argued that today's schools face unprecedented challenges in preparing students for the unpredicted global workplace. As such, the student's ability to achieve academically is very essential. Particularly, math competence is of great significance for any student analytic and reasoning skills, therefore, basic computational skills are required in academics.

Parkinson (2009) posited that supplemental instruction has long history and has been proven to be effective in the US. Parkinson carried out a carefully controlled study of the effects of peer assisted learning by first year students with first year students. At the start of the study, both tutored and non-tutored groups were evenly matched. However, after one semester of tutoring, the students' calculus test scores increases by approximately 13%. Rittle-Johnson and Koedinger (2009) carried out experimental studies with two grade six schools in the UK, with sample number, n = 77 and 22 respectively. In both experiments the researcher discovered that the students who exposed to iterative sequencing lessons gained more knowledge in arithmetic. Also, the students were able to transfer the procedures learned to problem in novel settings. In this scenario, students could make clearer connection with the math concepts and their applicability.

According to Montague, Krawec, Enders, and Dietz (2014), results of the Bayesian analyses indicated that the (solve-it) instructional intervention of a cognitive intervention strategy was somewhat stronger for low-achieving mathematics students than for average-achieving students from a group of grade seven (n =1059) of 40 middle schools in a large urban district in USA. That is, 644 in the research-based cognitive intervention strategy group and 415 in the comparison group. Overall, the intervention program was effective for the varying ability groups and is quite appropriate for students with varied math abilities.

Akinsola and Frederick-Jonah (2014) used ANCOVA statistics analysis in a pretest-posttest control group quasi-experimental design, that is, 344 pupils from 12 public primary schools in Nigeria. The results revealed that students exposed to game and

poem enhanced instruction intervention (i.e., treatment group) have better mean achievement score than the control group. But game was found to be more effective in improving pupils' mathematics achievement than poem.

A study (which investigated the effects of self and cooperative learning strategies on secondary student's attitude towards math) adopted pre-test and post-test, control group quasi-experimental design using a 3 ×2 ×2 factorial matrix with two experimental groups and one control group, with sample number 350 from six purposefully selected secondary schools in Ogun State. Analysis of Covariance (ANCOVA) and Scheffé *post hoc* analysis were the statistical procedures used for data analysis. Analyses revealed that math teachers should be trained to use self and cooperative learning packages in the math classroom, because these strategies impact students' math attitudes positively (Mohammad-Hassan, Farhad, & Nasrin, 2014).

Finally, in a 3-year randomized control study discovered that over time coaches positively affected student achievement in grades3, 4, and 5. In this scenario, this significant positive effect on student achievement was not evident at the end of the first year of placement of a coach in a school, but emerged as knowledgeable coaches gained experience and as the stakeholders at the school worked collaboratively (Campbell & Malkus (2011).

The above math interventions/ instructional approaches in the math classroom provide insights for possible strategies that could be used to improve mathematics instruction at the local level. Indeed, sometimes educators will have to think out of the box to maintain the reciprocity between teaching and learning. The results relating to

students' math and anxiety tests supported this notion, because a novel interventional project of anxiety reduction produced significant *p*-values.

Notes Taking

Classroom settings have changed a lot, particularly, with the advent of computer and technology. In a recent research, a lecture was done by a professor in person in 20 minutes, during this time the students took notes. Subsequently, the same lecture, was given by a podcast, during the podcast delivery the students took notes. The findings revealed that those students who took notes while listening to the podcast scored significantly higher (Mckinney, Dyck, & Luber, 2009). So, not only are note taking important, but also clarity one gets when writing the notes. Brazeau (2009) notes that notes taking facilitates active learning, but this can hampered when students are given lots of handouts, because students would not be involve in the process of identifying, collecting and organizing information.

In recent times computer technology enables notes takers to perform better on immediate test, and also they will retain the information better thus they will perform much better in delayed test of one week later (Beck, Hartley, Hustedde, & Felsberg, 2014). However, Mueller and Oppenheimer (2014) argued that taking notes with the hand is much better to do when the learner is required to recall numerous amounts of concepts. In the case of mathematics, most students who take notes in the face-to-face lectures perform better in math tests. Correlational analyses of data from three experiments of different ways to taking notes revealed that for those who took notes in an organized fashion, working memory predicted note-quantity, which predicted recall on both

immediate and delayed tests (Bui, Myerson, & Hale, 2013). Hence the variable of test performance can be predicted from these predictor variables. In this case, multiple regression analysis is most suitable. In the qualitative settings, notes taking of written note, videotaping, and tape recording forms mostly use, Muswazi and Nhamo (2013) concluded that once permission is given, videotaping is the best form of notes taking. All in all, the studies reviewed revealed that for quantitative classroom settings the hand written form of taking notes would impact students test scores positively.

Motivation and Attitude

Papastergiou (2009) revealed that educational computer games can be exploited as effective and motivational learning environments, despite gender difference. In this case, a sample of 88 Greek students did a pre-and posttest. Also, feedback of students' questionnaires supported the computer gaming approach. Cleary and Chen (2009) in a study of 880 suburban middle school students, the analysis of variance was utilized for the group differences in student self-regulation and motivation. Also, the linear regression was used to depict variables that best predicted students' use of regulatory/motivational strategy. A finding from the study revealed that achievers (i.e., those satisfactory academic performances) were more motivated. Students drive their own learning when they are involved in project based learning (PBL), this is the learning approach to develop critical thinking strategies in the 21st century (Bell, 2010). Additionally, with the usage of computer and technology students can be more motivated to work much harder to overcome mathematical and other educational challenges. A study of 1,719 Portuguese students, of fifth-to-twelve graders in a hierarchical analysis

using equation modeling showed that motivation-related variables are the main predictors of attitudes towards math (Mata, Monteiro, & Peixoto, 2012).

Likewise teachers and social support of peers are crucial in understanding these attitudes (Mata, Monteiro, & Peixoto, 2012). According to Kalder and Lesiki (2011), recommendations in exposing pre-service teachers to positive attitudes and beliefs about math are essential for students in the math classroom. If this attitude is not displayed in the classroom by teachers then students will not develop good attitudes for the subject. Mohamed and Waheed (2011) showed a sample of 200 secondary students completed questionnaires to find out their math attitudes, the questions were based on personal confidence, perceived usefulness of the subject. The results showed that the students' had average attitude, but there was no gender difference in their attitudes. Adeyinda and Kaino (2012) demonstrated in an analysis that math achievement at the senior secondary school level in Bostswana was significantly influenced by positive attitude. Lazarides and Ittel(2012) examined a sample of 361 students in Grades 8, 9, 10 (41.3% female) attending ten public schools located in Berlin, Germany. Findings revealed a positive effect of perceived parental school support on students' interest. However, there was a negative effect of perceived teacher support on students' grades. Gender differences did not differ for ethnic groups but attitudes were strong predictors of math achievement, which was consistent with hypotheses (Else-Quest, Mineo, & Higgins, 2013).

Furthermore, at the higher education level of graduate and undergraduate students (N = 384) who completed the Index of Learning Styles and Attitudes Towards Mathematics Inventory and findings suggested that STEM majors have more positive

attitudes toward mathematics, while gender and race do influence both learning styles preference and attitudes toward mathematics (Middleton, Ricks, Wright, & Grant, 2013). It is believed that the teacher attitude toward math impacts the students' attitudes of math and ultimately the students' performances. For example, in a sample of 100 students and four math teachers making a total of 104 respondents, the students were randomly sampled while the teachers were purposefully sampled. Questionnaire data and end of term exam were used as the measures. It was then revealed a significant relationship between teacher attitude and student attitude toward mathematics. Therefore, the positive teacher enabled positive students, which was demonstrated in the students' exam scores (Mensah, Okyere, & Kuranchie, 2013).

Other Ways of Reducing Math Anxiety

Math anxiety can be reduced three different ways, which include: Curricular, instructional, and non-instructional (Iossi, 2007). In adult education curriculum, an audience response system (ARS) allows students to respond to multiple choice questions using a remote control device. The responses are instantly displayed in a chart form and are then discussed by the instructor and the class (Kay & LeSage, 2009). In this scenario, students who are not very confident in working a math question can also participate by using the remote system. From an instructional point of view, a cooperative learning group can drastically reduce chemistry anxiety. In a quasi-experimental design that took place in senior secondary schools in South-West Nigeria, for example. 120 students were randomly selected into two groups. The groups were cooperative learning and conventional method (i.e., chalk-and-talk), which were both pretested in chemistry. At

this stage both groups demonstrated a high level of understanding for the subject. However, after the post-testing, the participants in the cooperative learning group had their chemistry anxiety reduced significantly (Oludipe & Awokoy, 2010).

Gresham (2009) found a negative correlation, r = -0.475 for a group (n = 156) of pre-service math teacher efficacy and math anxiety in elementary teachers. Hence, a way to reduce that high level of math anxiety in pre-service teaching is to introduce staff training programs to boost their self-efficacy. Students (N = 80) varying in math anxiety were asked to sit quietly (control group) prior to completing difficulty-matched math and worded algebraic problems or to write and express their thoughts and feelings regarding the exam they were about to take (expressive writing group. The results have shown that the writing group did significantly better than the control group. In essence, writing did reduce anxiety prior to the test experience (Park, Ramirez, & Beilock, 2014).

Cognitive-Restructuring treatment (i.e., is the training of students to develop thinking pattern or perceptions, that is, to use desensitization techniques) a strategy to reduce anxiety in Mathematics (Asikhia, 2014). A 2 x 2 x 3 pre-test, post-test factorial design (treatment, gender, and study habit) was used in the study, the sample being mathematics anxious students who were randomly assigned to one experimental group and one control group of 90 males and 90 females respectively. A greater interference effect was found for response times (ERP's) in the 17 high math anxiety (HMA) group than in the 17 low math anxiety (LMA) one. In this scenario, math anxiety is related to a reactive and compensatory recruitment of control resources that is implemented only when previously exposed to a stimuli presenting conflicting information. That is,

congruency reduces the math anxiety behavior/cognitive positively (Suárez-Pellicioni, Núñez-Peña, & Colomé, 2014). It is important to note the results of more studies should to be taken from both the teachers' views and also the need to look at pupils' views to get deeper understanding of the information about the topic and to structure the ways of reducing anxiety in mathematics based on views of both sides (Alkan, 2013). However, the results of this project study were taken from the analysis (researcher's view) and the views of math students' on math anxiety reduction in the math lab.

Implementation

Because the project study is considered to be a pilot study, therefore the implementation stages would be as follows. (1) The findings of the study would be presented in a brief and comprehensive manner. (2) The study would be done on a larger scale. (3) Different instructional approaches to be explored as recommended based on feedback provided on questionnaire. The head of school, Dean of Faculty, the instructors would be presented with details of the aforementioned. Subsequently, I would plan to replicate the research with a larger sample. This would facilitate generalization to a larger population. In doing this, more persons would become aware of the problem. With a larger sample, the Minister of Education would be convinced that the problem needs immediate attention, if in fact the findings could be replicated.

Potential Resources and Existing Supports

Electrical components, namely: headphone preamplifier, 2 laptops, (30-40) feet length conductor wire, 2 EEG equipment, headphone plug in boxes, other electrical fittings, and headphone input boxes. Currently, $500,000.00 is allocated as a grant. This

sum of money is available for research based projects being conducted by one researcher. However, if two persons collaborate the assessable sum would be $1,000,000.00

Potential Barriers

Below are some factors that impacted this research project. First, perhaps, research studies conducted properly are time consuming. It would be recommended that other doctoral students interested in conducting research further could be made aware of this pilot study. Second, adult students will have limited time to spend in math lab for treatment sessions. Therefore, future researchers should be made aware of this fact. Hopefully, arrangements can be made for adults to access the treatment at home through online availability. Additionally, research could also be conducted with traditionally aged students. Third, there was an attrition rate of students due to a deregistration system for late fees payment. This researcher is not sure what to do about this issue.

Proposal for Implementation and Timetable

Implementing this educational reform policy (i.e., given consideration to reduce students' math anxiety) requires organizations to implement change in order to correct student's math anxiety and improve math competence. This policy is pertinent because of the high failure rate in precalculus math and generally poor math competency skills. Consequently, the Dean of FOSS will be consulted to inform the respective heads of departments and committees. In this case, majority of the instructors and students will be informed about the policy to be drafted into the university's curriculum. That is, the feedback on the questionnaire items, particularly, time management and instructional approaches. As such, beneficiaries will never feel as if they treated with favoritism or

unfairly. This policy recommendation for the proposed project will be effective at the beginning of each semester and runs for the entire 13-week semester. In the six to seven week the proposed project's treatment will be administered to experimental treatment group. Subsequently, the controlled group will receive experimental treatment.

Roles and Responsibilities of Student and Others

The stakeholders to be involved with the policy recommendation are: the Dean of FOSS, Heads of divisions/committees, instructors, and students. The role of each person will be listed as follows. First, the role of the dean is to inform the recommended policy major role of instructors. Second, heads of divisions to inform workers. Third, the instructors will inform students and provide them with brochures of the proposed project. Finally, students will be the recipient of the proposed project to reduce math anxiety; hence the students' math test scores will be improved.

Project Evaluation

For this project, goals-based and progress-based evaluations will be used as assessment tools. This approach is important due to decreasing funds and increasing stakeholders calls for improvement of students' performances in math all levels in Jamaican schools. There is the need to measure the effectiveness of projects. This approach will allow the stakeholders to measure whether, and how projects make real difference in the lives of students may be evaluated. In doing these evaluations, light will be shed on what works and what needs amendment. Hence positive social change can be fostered.

Implications Including Social Change

Local Community

In fostering positive social change, this project will be addressing the needs of learners in my local community, by impacting positively greater awareness and treating math anxiety. The effect of reducing math anxiety will improve students' math test score. In this case, students, families, instructors, administrators, and community partners will be beneficiaries by sustaining this project.

Far-Reaching

I have developed a website which provides information about math anxiety and its treatment for introductory math students (i.e.,www.themusicofmath.com). Since math incompetence has been a major concern to stakeholders globally, Mbugua, Kibet, Mutha, and Nkonke (2012) revealed that math performance by students has continuously been poor in secondary schools in Kenya. Hence, creating a website, other educators and students can gain access to this website through internet availability. Particularly, students and educators will both gain knowledge of identifying and treating math anxiety, therefore improving math test scores.

Conclusion

In summary, the description and goals, literature review, rationale, and implication to impact social change are great importance. But, most importantly is the ability for the practitioner to initiate the process, therefore, call to action, implement, and sustain the project are pertinent. Although, this can be a great challenge, the goals of the project can only be attained, if the stakeholders work in great collaboration both locally and

internationally for greater good. This collaboration can be maintained with the advent of computer and other technologies, as a way forward. Lastly, recommendations will be made for students who are severely mathematical anxious to see the mental health practitioner.

Report: Policy Recommendations

Project Title:

Policy Recommendations for Improving Math Pass Rate of Introductory Adult University Students

Dates of Project:

September 2013 – January 2014

Date of Recommendations:

March 2014

Section 1: Introduction

Recently, the head of the teachers' association in Jamaica and other stakeholders called for the improvement of mathematics performances by students at large. For several consecutive years the overall pass rate varied from 16-40 percent in standardized math exams. According to a recent article in the daily newspapers, all the improving countries have one thing in common, and that is a good mathematics teaching policy (Douglas, 2010). However, many Jamaicans have been performing poorly at math. Hence, improvements must be made, and the Minister of Education (Ronald Thwaites) called strongly for the exploration of new strategies to be administered in the teaching of mathematics all different levels.

At the school Mathematics and Statistics, in the Faculty of Science and port (FOSS), where I work (the University of Technology, Jamaica), provides teachers who teach mathematics courses for other faculties in the university community. Many of my colleagues are of the common view that much work is needed to be done in mathematics education to improve the introductory students overall math performance to at least 70%. I believe that the time has come for the teachers' of mathematics and mathematics-related courses and other stakeholders to become aware of: (a) math anxiety and intervention programs for reducing its impact on math student's test taking experience, (b) to apply academic theory support in mathematics education. In response to these two major concerns I have developed a project called "Reducing Math Anxiety through Musical Instrumental Tones" (RMATMIT) to minimize the high math failure rate locally. As, such, I will be presenting policy recommendations to the regional mathematics

coordinator Dr. Tameika Benjamin from the Ministry of Education in Jamaica. Hopefully, consideration will be given to the recommendations made. Besides making these recommendations, a major focus will be placed on the sharing of the research results and future research studies.

Section 2: Policy Recommendations

The recommendations are:

(1) The consideration of a math anxiety section with questions in any diagnostic testing instruments developed by the team of experts from the ministry's committee at the local level.

(2) To create a national awareness of math anxiety (i.e., via media communications).

(3) Sensitize the local teachers about math anxiety.

(4) To establish a website for online self-evaluation of math anxiety and possible treatment.

(5) To integrate academic support theory in the teaching of science, technology, engineering and mathematics (STEM), but more so mathematics.

(6) The promotion of academic momentum in higher learning and adult education

Section 3: Background

For this white paper, the structural underpinning for this framework is the change theory. As mentioned in section 1, it is imperative for students to improve their math performances and to be aware of their levels of math anxiety. Hence, a local thrust can be applied to correct these two problematic areas of adult math students at the university

level. Weiner (2009) posited that change theory is organizational readiness for change and development through determinants and outcomes.

Generally, research in the areas of (test taking skills, study skills, teacher professional development, better diagnostic tests for mathematics improvement that extends down to basic mathematics skills ought to be explored, etc.) is needed. Much more should be done in terms of research and program support so students can be successful, etc. In addition, feedback from the students on a self-developed questionnaire revealed that more attention is needed in the following areas: time management, instructional strategies, study skills, test wiseness, motivation and attitude, and other ways of reducing anxiety.

Section 4: Methodology

For this secondary analysis of data collected using a quantitative wait-control group design, there are two major analysis techniques: the Pearson product moment correlation and the independent sample t-test, which will be used in the control and experimental groups of a sample of 48 participants. There were 27 1nd 21 students in the experimental and control group respectively. The overall data analyses used were inferential statistics (i.e., correlations, *t* test, and multiple regressions) and descriptive statistics (i.e., box plots, scatter plots, and graphs). In addition, footnotes were provided to further explain symbols and abbreviations so that consumers of research will be able to fully interpret the research findings. Of course, these analyses might be appropriately presented in this research project study to be disseminated and correspond to the theoretical and conceptual frameworks of the study.

Section 5: Dissemination of Results

The research and alternate hypotheses are respectively: (a) Math anxiety (independent variable) is negatively correlated to students' math pretest scores (dependent variable), and (b) monaural beats/isochronic tones (independent variable) will impact positively students' posttest for math anxiety and mean precalculus test scores (dependent variables).

Hypothesis (a) proposed that there would be a significant negative relationship between math pretest scores and MARS-S scores for precalculus students. Consistently with my expectations, there was a correlation coefficient of $r(46) = -0.36$, $p = .002$, which is statistically significant. Therefore hypothesis (a) was supported. Additionally, Table 3 showed that student's pre -and post math anxiety and math test scores negatively correlated with insignificant p-values of greater than 0.05. Creswell (2009) asserted that fair correlation value of -0.26 and fairly weak values of-0.21 and -0.19, which that reflected the relationship between math anxiety and math pre-and post test scores for the treatment and control group. Also, from Table 3, the pre math anxiety and math test scores for the treatment group was statistically significant, that is, $r(19) = - 0.47$, $p = .05$

Next, the difference in means for the experimental and control groups, that is, group 1 and group 2 respectively, were compared. These means and other descriptive statistics can be found in Table 2 and Figure 1.Hypothesis (b) proposed that monaural beats/isochronic tones will impact positively students' mean posttest scores for math and anxiety. The mean difference between groups 1 and 2 was statistically significant at the specified .05 level, with appropriate effect size (d). That is, $t(44.49) = 3.99$, $p < .000$, $d =$

0.25, 95% CI [11.39, 34.68]. Thus, hypothesis (b) was accepted, which means the null hypothesis was rejected and alternate hypothesis accepted.

Besides, multiple regressions were not mentioned in my proposal as an analysis method to be employed in research study, mean differences for pre-test math scores were statistically and significantly different as there was more than a 10 point difference in pre-test scores in favor of the treatment group, in spite of the random assignment employed. Also, there were a few points difference between math anxiety pre-test scores, though it was not statistically significant. Therefore, multiple regression analyses were employed to control for these pre-test differences in post-hoc analyses to see if results were statistically significantly different. While adding pre-tests as a control proved to change the coefficients as expected, there were still statically significant group differences in favor of the experimental group using post-hoc analyses. These findings are presented in Tables 6 and 7. Finally, Table 5 showed that math anxiety was increased for the students of the control group. Whilst those students in the treatment group had their post math anxiety reduced at a significant level.

Levels of anxiety of the precalculus students revealed that the mean value is very close to the range of values that were indicated by the authors of the MARS-S instrument. This range (35 to 120) is seen in Table 3 and Figure 2. As such, the prevalence of math anxiety is confirmed. It can be seen that 25 percent of the students had anxiety (i.e., 17 students receiving anxiety scores 75 percent and over). Figures 3, 4, 5, 6, and 7 revealed the students' performances in the pre-and posttests with and without treatment. Finally, the averages and standard deviations found in this research are, 64.70(20.67). However,

while those in the control group received mean math test score and standard deviation of 41.67 (19.22) respectively. Additionally, the mean math anxiety score of 75.47 was found for the control group**.**

In addition to descriptive and inferential statistics, both significance levels and standard errors are presented, which follows social sciences research data presentation standards. The items on questionnaire (i.e., Appendix E, with six closed ended question items) that the majority of the pre-calculus students responding when asked what they would like more information on are: (a) test strategies and notes taking, 78.1% respondents answered yes; (b) instructional strategies, which was represented by 100% of the students saying yes to the closed ended questions; and (c) motivation, 73.2% answered yes.

Section 6: Summary

The results (i.e., t-test and correlation) of this research shed light on the guiding research question, that is, to show the relationship between precalculus test scores and isochronic tones, an effect size value was calculated, which is 0.25. The effect size (d) showed that the students who were treated with isochronic tones received mean math test score with standard deviation of higher values. However, while those in the control group received mean math test score and standard deviation of lower values. Additionally, the mean math anxiety score was higher than normal accepted of 75% attained by students in the study confirms that the math anxiety problem does exist among the introductory precalculus students.

As a result of the outcome of this research study, a project of the intervention that reduces math anxiety and improving math test scores of introductory math students can impact many lives positively. In this case, audio brain stimulation for students who are motivated and understand the importance of test strategy skills, with good math attitude can be promoted.

Section 7: Recommendations for Future Research

Furthermore, arts education (i.e., audio, music, and performance arts) have been hot topics of discussion among educators/researchers to reduce high failure rates in the math classroom. With this project study, other doctoral students can use it as a pilot study to pursue doctoral studies in mathematics education. Because this project study focused on the impact of beats/tones on reducing math anxiety others research could be conducted on performing arts. Lastly, research done with larger sample number (i.e., greater than 48, which was used in my study) would provide valuable quantitative information for consumers of research. In this case, generalization can be made about the research that is being conducted. Therefore, a more national impact of math anxiety reduction can be fostered. Additionally, designing and analyzing research based studies that randomize schools to estimate intervention effects.

Appendix B: Pretest (College Math 1A)

UNIVERSITY OF TECHNOLOGY, JAMAICA

MODULE: COLLEGE MATHEMATICS 1A
MODULE CODE: MAT1044

TEST CODE: MAT 1044 - 01 **DATE: OCTOBER , 2012**

DURATION: 75 MINUTES

INSTRUCTIONS: ANSWER ALL QUESTIONS in both sections.

NAME _____ **ID #** _____

SECTION A(15 marks)

1. Given that Z represents the set of integers, which of the following is **NOT** a member of the set $M=\{x: x\in Z, -2\le x<7\}$
   (a) 7
   (b) 5
   (c) $\sqrt{4}$
   (d) -1

2. Which of the following is a **rational** number
   (a) π
   (b) $\sqrt{3}$
   (c) $\sqrt{4}$
   (d) $\sqrt{-1}$

3. The set of real numbers less than 1 and greater than or equal –1 can be written in interval notation as
   (a) (-1, 1]
   (b) [-1, 1)
   (c) (-1, 1)
   (d) [-1, 1]

4. The interval [-3, 7] written in set builder notation is
   (a) $\{x: x\in\Re, -3\le x\le 7\}$
   (b) $\{x: x\in\Re, -3< x< 7\}$
   (c) $\{x: x\in\Re, -3\le x< 7\}$
   (d) $\{x: x\in\Re, -3< x\le 7\}$

5. If $A=(-\infty,9)$ and $B=(0,11]$, then $A\cap B$ is
   (a) (0, 9)
   (b) [0, 9]
   (c) [9, 11)
   (d) [9, 11]

6. Given that $A=\{x: x\in\Re, -2<x\le 4\}$ and $B=\{x: x\in\Re, 1\le x\le 12\}$, then $A\cap B$ is
   (a) [1,4]
   (b) [-2,12]
   (c) $(-\infty,-2)\cup(12,+\infty)$
   (d) $(-\infty,-2]\cap[12,+\infty)$

7. Which statement below does **NOT** represent $x\neq 7$
   (a) $x<7$ or $x>7$
   (b) $x<7$ and $x>7$
   (c) $\{x: x\in R, x\neq 7\}$
   (d) $(-\infty,7)\cup(7,\infty)$

8. $(2a-b)^2$ is the same as :
   (a) $4a^2+b^2$
   (b) $4a^2-b^2$
   (c) $4a^2+4ab+b^2$
   (d) $4a^2-4ab+b^2$

9. A factor of x^3-7x+6 is :
   (a) $x+2$
   (b) $x-2$
   (c) $x-3$
   (d) $x+1$

10. If $x(2x-4)=0$, then x is equal to :
   (a) 0 or -1
   (b) 1 only
   (c) 0 or 1

(d) 0 or 2

11. Find the remainder when $3x^3 - 2x^2 + x - 5$ is divided by $x + 1$:

(a) -11
(b) -5
(c) 2
(d) 5

12. $\left(\frac{8}{27}\right)^{-2/3}$ is equal to

(a) -4/9
(b) 4/9
(c) 9/4
(d) -9/4

13. Solve the equation $2^{x+5} = 1$ for x:

(a) -5
(b) 0
(c) 1
(d) 2

14. Simplify $2^p \times 4^{1-p}$.

(a) 4
(b) 12
(c) 2^{1-p}
(d) 2^{2-p}

15. $\sqrt{\frac{(4xy)^2}{(2x)^2}} =$

(a) x^2
(b) $2x$
(c) $2y$
(d) y

SECTION B

16.(a) By representing the sets $A=(-21,-2]$ and $B=[-15,\infty)$ on the number line, find:

$$(A\cup B')$$

[3marks]

(b) A polynomial is defined by $f(x)=x^3+2x^2-x-k$.

(i) Given that $x-1$ is a factor, find the value of *k*.

(ii) Factorise $f(x)$ completely.

(iii) Hence, or otherwise, solve the equation $x^3+2x^2-x-k=0$. **[2 +4 +3 marks**

(c) Simplify the following expression by applying appropriate laws of indices:

$$\frac{2ab^4}{4\left(a^2b^{-1}\right)^3}$$

[3 marks]

(d) Solve the following equation for the unknown:

$$2^{2x}-3(2^x)+2=0.$$ **[3 marks]**

****END OF TEST****

Appendix C: Posttest (College Math 1A)

UNIVERSITY OF TECHNOLOGY, JAMAICA

MODULE: COLLEGE MATHEMATICS 1A
MODULE CODE: MAT1044

TEST CODE: MAT 1044 - 01 **DATE: OCTOBER , 2012**

DURATION: 75 MINUTES

INSTRUCTIONS: ANSWER ALL QUESTIONS in both sections.

NAME _____ ID # _____

SECTION A(15 marks)

1. Given that Z represents the set of integers, which of the following is **NOT** a member of the set $M=\{x:x\in Z,-4\le x<8\}$
   (a) 7
   (b) 5
   (c) $\sqrt{4}$
   (d) *irrational*

2. Which of the following is an **irrational** number
   (a) π
   (b) $\sqrt{3}$
   (c) $\sqrt{4}$
   (d) $\sqrt{-1}$

3. The set of real numbers less than 2 and greater than or equal –2 can be written in interval notation as
   (a) (-2, 2]
   (b) [-2, 2)
   (c) (-2, 2)
   (d) [-2, 2]

4. The interval [-4, 8] written in set builder notation is
   (a) $\{x:x\in\Re,-4\le x\le 8\}$
   (b)
   (c)
   (d) $\{x:x\in\Re,-4<x\le 8\}$

5. If $A=(-\infty,8)$ and $B=(0,12]$, then $A\cap B$ is
   (a) (0, 8)
   (b) [0, 8]
   (c) [8, 12)
   (d) [8, 12]

6. Given that $A=\{x:x\in\Re,-2<x\le 4\}$ and $B=\{x:x\in\Re,1\le x\le 12\}$, then $A\cap B$ is
   (a) [1,4]
   (b) [-2,12]
   (c) $(-\infty,-2)\cup(12,+\infty)$
   (d) $(-\infty,-2]\cap[12,+\infty)$

7. Given that the expression $x^2 + 8x^2 - 4x - k^2$ is divisible by $x - 2$. The values of k are:
   (a) $4\sqrt{2}$ and $-4\sqrt{2}$
   (b) $3\sqrt{2}$ and $3\sqrt{2}$
   (c) $5\sqrt{2}$ and $3\sqrt{3}$
   (d) $\sqrt{5}$ and $2\sqrt{5}$

8. $(a-3b)^2$ is the same as :
   (a) a^2+9b^2
   (b) $a^2-6b+9b^2$
   (c) $4a^2+4ab+b^2$
   (d) $4a^2-4ab+b^2$

9. A factor of x^3-1 is :
   (a) $x + 2$
   (b) $x - 2$
   (c) $x - 3$
   (d) $x-1$

10. If $x(4x-8)=0$, then x is equal to :
   (a) 0 or -1
   (b) 1 only
   (c) 0 or 1

(d) 0 or 2

11. Find the remainder when $3x^3 - 2x^2 + x - 5$ is divided by $x + 2$:

(a) -32
(b) -5
(c) 2
(d) 5

12. $\left(\frac{64}{125}\right)^{-2/3}$ is equal to

(a) -25/16
(b) 16/25
(c) 25/16
(d) -16/25

13. Solve the equation $9^{x+5} = 1$ for x:

(a) -5
(b) 0
(c) 1
(d) 2

14. Simplify $8^p \times 4^{1-p}$.

(a) 4
(b) 12
(c) 2^{1-p}
(d) 2^{p-2}

15. $\sqrt{\frac{(8xy)^2}{(4x)^2}} =$

(a) x^2
(b) $2x$
(c) $2y$
(d) y

SECTION B

16.(a) By representing the sets $A=(-20,-4]$ and $B=[-17,\infty)$ on the number line, find:

$(A\cup B')$ **[3 marks]**

(b) A polynomial is defined by $f(x)=x^3+4x^2-2x-p$.

(i) Given that $x-1$ is a factor, find the value of p

(ii) Factorise $f(x)$ completely.

(iii) Hence, or otherwise, solve the equation $x^3+4x^2-2x-p=0$.

[2 +4 +3 marks]

(c) Simplify the following expression by applying appropriate laws of indices:

$$\frac{4ab^6}{8\left(a^2b^{-1}\right)^4}$$ **[3 marks]**

(d) Solve the following equation for the unknown:

$4^{2x}-6(2^x)+4=0.$ **[5 marks]**

****END OF TEST****

Appendix D: Math Anxiety Rating Scale–Short Version

NAME _____ Total Score _____

MATHEMATICS ANXIETY RATING SCALE: SHORT VERSION

The items in the questionnaire refer to things that may cause fear or apprehension. For each item, place a check in the box under the column that describes how much you are frightened by it nowadays. Work quickly but be sure to consider each item individually.

	Not at all	A little	A fair amount	Much	Very much
1. Taking an examination (final) in a math course.	☐	☐	☐	☐	☐
2. Thinking about an upcoming math test one week before.	☐	☐	☐	☐	☐
3. Thinking about an upcoming math test one day before.	☐	☐	☐	☐	☐
4. Thinking about an upcoming math test one hour before.	☐	☐	☐	☐	☐
5. Thinking about an upcoming math test five minutes before.	☐	☐	☐	☐	☐
6. Waiting to get a math test returned in which you expected to do well.	☐	☐	☐	☐	☐
7. Receiving your final math grade in the mail.	☐	☐	☐	☐	☐
8. Realizing that you have to take a certain number of math classes to fulfill the requirements in your major.	☐	☐	☐	☐	☐
9. Being given a "pop" quiz in a math class.	☐	☐	☐	☐	☐
10. Studying for a math test.	☐	☐	☐	☐	☐
11. Taking the math section of a college entrance exam.	☐	☐	☐	☐	☐
12. Taking an examination (quiz) in a math course.	☐	☐	☐	☐	☐
13. Picking up the math text book to begin working on a homework assignment.	☐	☐	☐	☐	☐
14. Being given a homework assignment of many difficult problems which is due the next class meeting.	☐	☐	☐	☐	☐
15. Getting ready to study for a math test.	☐	☐	☐	☐	☐

	Not at all	A little	A fair amount	Much	Very much
16. Dividing a five digit number by a two digit number in private with pencil and paper.	☐	☐	☐	☐	☐
17. Adding up 976 + 777 on paper.	☐	☐	☐	☐	☐
18. Reading a cash register receipt after your purchase.	☐	☐	☐	☐	☐
19. Figuring the sales tax on a purchase that costs more than $1.00.	☐	☐	☐	☐	☐
20. Figuring out your monthly budget.	☐	☐	☐	☐	☐
21. Being given a set of numerical problems involving addition to solve on paper.	☐	☐	☐	☐	☐
22. Having someone watch you as you total up a column of figures.	☐	☐	☐	☐	☐
23. Totaling up a dinner bill that you think overcharged you.	☐	☐	☐	☐	☐
24. Being responsible for collecting dues for an organization and keeping track of the amount.	☐	☐	☐	☐	☐
25. Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at different speeds.	☐	☐	☐	☐	☐
26. Totaling up the dues received and the expenses of a club you belong to.	☐	☐	☐	☐	☐
27. Watching someone work with a calculator.	☐	☐	☐	☐	☐
28. Being given a set of division problems to solve.	☐	☐	☐	☐	☐
29. Being given a set of subtraction problems to solve.	☐	☐	☐	☐	☐
30. Being given a set of multiplication problems to solve.	☐	☐	☐	☐	☐

Appendix E: Feedback Questionnaire

Feedback Questionnaire for Math Anxiety Students in the Math Lab.

Would you like more information on:

	Yes	No
(a) time management ;	0	0
(b) study aids and note taking;	0	0
(c) test strategies	0	0
(d) Other ways to reduce anxiety;	0	0
(e) motivation and attitude	0	0;
(f) instruction (tutoring, afterschool help, etc.)		

Appendix F: Permission Documents for Instruments

Subject : Re: Math Anxiety Rating Scale

Date : Wed, Dec 07, 2011 12:26 PM CST

Copies of the 30 item MARS for adults/college students are available. However because they are commercially
produced, the smallest packet is 100 tests at $40 + cost of postage + 45 handling/100 copies ordered. As the
enclosed indicates, all international orders will be shipped as soon as prepayment is received. Also international
orders must be sent through Western Union; no other form of payment is acceptable. My estimate of total cost
for delivery 5-7 days express first class mail to Jamaica is: $40 100 tests + $30 postage + $5 handling = US$75.00
Western Union payment.
If you submit an order and prepay via Western Union, I will need the number that Western Union gives you, your
name and address and phone number. My name/address: Richard Suinn, 808 Cheyenne Drive, Fort Collins, CO.
Thank you for your interest. Note: I shall be out of town Dec 20 - Feb 5.

Subject : Re: Math Anxiety Rating Scale

Date :	Thu, Dec 08, 2011 04:24 PM CST
From :	
To :	
Attachment :	MARS_Sample__Brief.doc

For your IRB, attached is a sample page used by other IRBs at other locations. Below is some info on reliability/validity.

Reliability. A test-retest reliability coefficient for the MARS-S was calculated from the scores of college students retested one week later. The reliability coefficient of 0.90 (p = < .001) compares quite favorably with the reliability for the longer MARS of .90 for the same period.

An internal consistency reliability coefficient, Cronbach alpha was found to be 0.96 comparable to the 0.97 for the longer MARS. In effect, this shows that the average intercorrelation of the items in the test is quite high. It confirms that the test is highly reliable and indicates that the test items are heavily dominated by a single, homogeneous factor, presumably mathematics anxiety.

Validity. On a college sample, correlations between the MARS-S and the longer MARS were found to be r =-.92 (p< .001) for the original testing and -.94 (p <.001) when both tests were readministered one week later. Hence the MARS-S appears to be equivalent to the MARS.

As further validation MARS-S scores were inversely correlated with grades in mathematics ($r = -.41$, $p < .001$). The negative correlation was expected since high mathematics anxiety would have a negative influence on mathematics performance.

It might also be hypothesized that high mathematics anxiety leads to avoidance of mathematics-related activities, such as choice of majors or choice of careers that involve mathematics. Biserial correlations between the MARS-S and choice of mathematics-related majors was found to be -.36 ($p < .001$) and -.30 ($p < .001$) between MARS-S and choice of mathematics-related careers. Thus persons showing high mathematics anxiety tend to perform poorly in mathematics courses and avoid college majors or careers which involve mathematics.

Content Validity. Factor analysis of the MARS scores indicated the presence of two primary factors, the first accounting for 59.2% of the variance and the second 11.1%. This is consistent with other studies identifying two major factors for the longer MARS. There were 22 test items showing loading on either of these two primary factors.

Subject : Re: [Communication via the contact form] : Re; Isochronic Tones

Date : Sun, Dec 04, 2011 10:57 PM CST

Hi Glenroy,

Actually, each student should listen from an ipod or CD source and with stereo headphones.

As it is the space between pulses that matters you do not really need to worry about the headphones or sources being the same, only that the sources do not distort and reproduce the tones accurately.

Each participant should also get to choose the recording they like the best (in the case of the multiple choice recordings).

Each person preference may vary and this is why the choice must be theirs in order to maintain parody (people will normally chose the one they like best as it will also be the pone the works best for them).

Let me know if you need anything else and I'm here for you if you need me along the way.

I'm here for you.

Morry

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President : Professor the Hon. Errol Morrison OJ, MD, PhD, FRCP (Glasg), FACP, FRSM (UK), FRSH

February 19, 2013

The Doctoral Study Committee
Institutional Review Board
Walden University

Dear Sir/Madam,

This serves to confirm that effective August 2012; Mr Glenroy Pinnock has assumed the role of a Full Time Lecturer in the School of Mathematics and Statistics of the Faculty of Science and Sporty at the University of Technology, Jamaica. This was necessary to facilitate his passion for the teaching and advancement of the discipline at the university. He was formerly assigned to the Physics Division in the same Faculty.

I will support his research activities by not allowing him to teach or tutor any of the College mathematics 1A groups during the summer session when he will be engaged in the data collection stage of his research. The necessary arrangement will be implemented to ensure that Mr Pinnock's timetable for the summer does not contain any College mathematics 1A classes. I am aware of the ethical considerations regarding his involvement with the students at this stage

The School will ensure that the marking of the measuring instruments for this research is not conducted by Mr Pinnock. Additionally, the data collected will be placed in a secure filing cabinet in the School.

I hope you find this information valuable to the future research project.

Yours sincerely

Errol Rowe
Head, School of mathematics and Statistics
Faculty of Science and Sport

University of Technology, Jamaica

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Jamaica, West Indies.
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President : Professor the Hon. Errol Morrison OJ, MD, PhD, FRCP (Glasg), FACP, FRSM (UK), FRSH

The Doctoral Study Committee
Walden University Research Review

Dear Sir/Madam,

I write in relation to the granting of permission to Glenroy Pinnock to use October 2012, Past Paper test of the College Mathematics 1A, as an instrument in his upcoming Research Project. The reliability and validity of this test paper is summarized below.

The reliability coefficient was found to be 0.7965 in a pilot study that was conducted on a group of thirty five (35) students. The internal consistency of the items of this mathematics test revealed that the scores for each item/question are equally distributed. As it relates to the construct validity, the significance, purpose, and use of the scores of the participants are pertinent for the quantitative design. In addition, the content validity revealed that the questions and scores from these questions is a representation of the possible questions of the specified content.

I hope you find this information valuable to the future research project.

Yours sincerely

Errol Rowe
Head, School of mathematics and Statistics
Faculty of Science and Sport

Informed Consent for Adult Students

This form is part of a process called "informed consent", which is to seek permission from you of becoming a participant in the study. Also, I am helping you to understand the study before a decision is made for your participation.

This study will be conducted by a research practitioner named Glenroy Pinnock, who is a current doctoral student at Walden University. In addition, Glenroy lectures at University of Technology, Jamaica, (UTECH) in the departments of physics and math/statistics.

Background Information:

At a small urban university the pass rate of 74.9%, and 40% at the secondary level, reflect Jamaicans' dismal numeracy competency. Some likely influencing factors for this poor performance at the university level may be: math anxiety, crime, violence, and economic depression. These low results could account for Jamaica's low gross domestic product (GDP), which is single digit. Because of economical depression, there exists the need for reforming mathematics education. Although this change is needed, the prevalence of mathematics anxiety continues to persist locally and. Despite the gap in the practice of intervention programs to correct/minimize math anxiety locally, practitioners are conducting many studies internationally. Locally, the topic of math anxiety is a topical discussion by faculty staff members at regular departmental meetings. According to Furner and Gonzalez-Dehass (2011), many students tend to be affected by math anxiety, as a result, they freeze up; cringe when they are to do any form of computational exercise. Additionally there are some others dread taking math classes at the college level.

The purpose of this study is to investigate whether math anxiety can be treated through an intervention program of monaural beats/isochronic tones, thereby decreasing mathematics anxiety and hence, improving College Math 1A test scores.

Procedures:

If you agree to be in this study, you will be asked to: voluntarily participate in:

- 10 minutes duration
- 12 weeks
- three sessions per week

Here are some sample questions:

1. What is the relationship between the mean precalculus test scores (dependent variable) of University students with different levels of math anxiety (measured from the MARS questionnaire) and monaural beats/isochronic tones (independent variable)?
2. The study will test two hypotheses: (a) Math anxiety (independent variable) is negatively correlated to students' math pretest scores (dependent variable)
3. monaural beats/isochronic tones (independent variable) will impact students' posttest for math anxiety and mean precalculus test scores (dependent variable).

Voluntary Nature of the Study:

This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at UTECH will treat you differently if you decide not to

be in the study. If you decide to join the study now, you can still change your mind during or after the study. You may stop at any time.

Risks and Benefits of Being in the Study:

Being in this type of study involves some risk of the minor discomforts that can be encountered in daily life, such as beats should not be listened extensively at a very high volume.

With better scores in math, more students will be able to access jobs that are highly mathematically oriented. The minister of education is currently offering special financial assistance for students wishing to pursue math specializations,

Privacy:

Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept by the dean in a secured cabinet. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:

You may ask any questions you have now. Or if you have questions later, you may contact the researcher via 504-6323 email: glenroy.pinnock@waldenu.edu. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 1-800-925-3368, extension 1210. Walden University's approval number for this study

is **IRB will enter approval number here** and it expires on **IRB will enter expiration date.**

The researcher will give you a copy of this form to keep. (for face-to-face research)

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By signing belowI understand that I am agreeing to the terms described above.

Date of consent _____

Participant's Signature _____

Researcher's Signature _____

Curriculum Vitae

Glenroy Pinnock

Education

2009 – Present: Doctoral in Education at Walden University

2005 – 2007: Studied MSc in Applied Math from London University College

Ways Glenroy Pinnock has helped students both inside and outside his community

Founder of an evening institution "Math Supreme" in the year 1997. At this institution students are taught at least three CXC subjects in one year. This institution is located at 20 Storks street, May Pen PO, Clarendon, Jamaica.

Professional Association Memberships

2005 – Present member of American Association of Physics Teachers

Professional Activities

2014 – Present: Chair of Research committee at the School of Math and Statistics (UTech). Main Research Interest is "Reducing Math Anxiety through Musical instrumental Tones (RMATMIT)

2014 – Present: Coordinator of Math and Statistics Learning Centre (UTech)

February 20, 2014 National Math Exposition, Jamaica: Presented on Inclined Plane Making Work Done Easier

March 20, 2014 – Presented at Research and Technology Day 2014 (Utech): Presented a paper on the correlation Between Music and Mathematics Scores

May 27, 2014 – Presented a paper on "A quantitative Exploration of Math Anxiety Resulting in Low test Scores" at the1st International Conference on Education & Humanities

Employment History

2003 – Present: Lecturer of Math/Physics at the School of Math and Statistics, University of technology, Jamaica

2002 – Assistant Lecturer at the Department of Social Science University of West Indies, Mona, Jamaica