MATHEMATICS ANXIETY AND THE PRIMARY SCHOOL TEACHER: AN EXPLORATORY STUDY OF THE RELATIONSHIP BETWEEN MATHEMATICS ANXIETY, MATHEMATICS TEACHER EFFICACY, AND MATHEMATICS AVOIDANCE.

EDRS6900: Project Report

Submitted in Partial Fulfillment of the Requirements for the Degree of

Masters of Education [Concentration in Curriculum]

Of

The University of the West Indies

Sharon Jacqueline Jaggernauth

December 2010

Dr. Madgerie Jameson

School of Education
Faculty of Humanities and Education
St. Augustine

DEDICATION

For my mother Mrs. Alma Nadur-Jaggernauth.

"Tell me mathematics, and I will forget;
Show me mathematics and I may remember;
Involve me… and I will understand mathematics.
If I understand mathematics, I will be less likely to have math anxiety.
And if I become a teacher of mathematics, I can thus begin a cycle that will produce less math-anxious students for generations to come."(Williams, 1988, p.101)

ACKNOWLEDGMENTS

The poet Mary Stevenson describes life as journey along a beach upon which our footprints leave their indelible impression in the sand. Likewise, I describe my journey towards the completion of this work. This journey had been challenging, and not without setbacks and hurdles. It is just because of this that I know that I have not walked this journey alone. Along the way wonderful people have walked with me. As I look back at the beach at my back, there are some places where I see only one set of footprints in the sand, and I know that these were the times that they all carried me. I thank them all. The order in which I express my gratitude does not indicate their contribution to my work and my life.

I would like to first express my heartfelt gratitude to my Supervisor, Dr. Madgerie Jameson, who joined my journey very late in its duration. Her steadfast guidance, encouragement, friendship and emotional support, sharpened my focus and ensured the completion of this research project. Thank you for your unwavering confidence in me. You have my deepest respect and admiration.

I am blessed to have been supported by my colleagues at the School of Education, UWI, St. Augustine both academic and ancillary staff. In particular, I express my sincerest gratitude and appreciation to Dr. Arthur Joseph, for your consistent support over the years; Dr. Dorian Barrow, for your encouragement and interest in my progress; Ms. Rena Sookdeo for your advice, encouragement and emotional support; and Dr. Maria Byron, for your guidance early on in this work. I especially thank my colleague and friend, Ms. Shahiba Ali, for your friendship, encouragement, feedback, and support during this process.

My journey would not be possible without the love, encouragement and boundless support of my mother, Alma Nadur-Jaggernauth. Thank you for your love and prayers, and the comfort of your shoulder. Your dedication and devotion continue to sustain me.

ABSTRACT

The purpose of this study was to clarify the relationship between mathematics anxiety, mathematics teacher efficacy, and mathematics avoidance among primary school teachers in Trinidad and Tobago. The impact of mathematics anxiety on teachers' performance and efficacy has been under-researched in Trinidad and Tobago, making it difficult to make inferences about the extent to which mathematics anxiety among primary school teachers' impacts upon the teaching and learning environment. The quantitative study used a survey design. A self-reporting questionnaire was administered to 68 primary school teachers. Quantitative analysis used frequency distributions, means, standard deviations, correlational analyses; means difference tests, and analyses of variance to establish the direction and magnitude of relationships between variables, and to identify differences within and among the groups surveyed. Mathematics anxiety and mathematics avoidance were not evident among teachers in the sample; however, female teachers reported higher levels of mathematics anxiety and mathematics avoidance than male teachers. Teachers reported that they believed that they taught mathematics effectively and that they were comfortable teaching mathematics. High levels of mathematics anxiety were associated with low levels of self-efficacy increased and high levels of mathematics avoidance. There was no significant relationship between three constructs mathematics anxiety, mathematics teacher efficacy, and mathematics avoidance, and teacher variables of highest level of educational achievement, type of school at which they taught, the number of years they have been teaching, and current programme they were enrolled in.

Keywords: mathematics anxiety; mathematics teacher efficacy; mathematics avoidance; elementary education; mathematics education; elementary teacher; pre-service elementary teacher

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER 1 – Introduction

Background

Mathematics pervades daily life and is critical for individual and societal development. However, mathematics is also an area that raises concerns about students' numeracy and achievement, internationally and in Trinidad and Tobago. Extensive research into the factors that impact upon students' success in, and attitudes towards mathematics reveal students' individual learning styles (Sloan, Daane, & Giesen, 2002), lack of self-confidence (Brady & Bowd, 2005), low levels of conceptual understanding of mathematical concepts, and lack of parental support (Uusimaki & Nason 2004); the learning environment (Uusimaki & Nason, 2004); teachers' instructional practices, content knowledge, and beliefs about mathematics (Iossi, 2007; Vinson, 2001); and mathematics anxiety of both students and teachers (Shores & Shannon, 2007).

The personal experiences of this researcher have led to the belief that classroom experiences contribute to the development of strongly and deeply held attitudes towards mathematics and mathematical self-concept. Further, the historically teacher-centered nature of mathematics instruction in Trinidad and Tobago has created an intergenerational legacy of mathematics as a product and not a process. Teachers rely on chalk-and-talk and direct instruction. They emphasize rote learning and memorization of content. Their students acquire mathematical skills through drill-and-practice.

However, learning mathematics requires an environment that is supportive, collaborative, and promotes creative and critical thinking. It requires a teacher who is well qualified to teach mathematics – one who is conversant with the mathematical content; is skilled at using a variety of effective pedagogical strategies; and who possess a disposition towards teaching mathematics that inspires, motivates and encourages their students to learn mathematics. Additionally, the nature of education in Trinidad and Tobago is competitive and examination-oriented. This drives an over-emphasis on students acquiring procedural understanding over conceptual understanding of mathematical concepts (Battista, 1994). The end-result is individuals whose mathematical competence, efficacy, confidence, and self-concept have been severely compromised.

Informal conversations between this researcher and primary school teachers in Trinidad and Tobago sparked an interest in this area of study. Teachers articulated a general dislike for and fear of mathematics. When they shared their feelings about mathematics responses included “Mathematics is hard.” “I get a headache when I think about mathematics.” “Mathematics is only for bright people.” “I don’t have a math mind.” “Nobody in my family is good at mathematics.” Many of them indicated that they had performed poorly at mathematics while at school, from as early as pre-school.

Some teachers shared that they had not done mathematics beyond primary school because mathematics was not compulsory at the time. These felt that they did not have the required content knowledge and necessary mathematical foundation they need to be effective mathematics teachers. One teacher reported, “When it comes to teaching math I usually call my co-teacher to teach it, and I teach language.” Another added, “I probably don’t spend as much time teaching mathematics as I spend teaching language arts. I just don’t feel comfortable teaching it.” Interestingly, these primary school teachers had been teaching for more than five years possessed a Teachers College Diploma.

Primary school teachers comprise a diverse group of individuals. They vary in age, gender, educational background, level of professional training, number of years of teaching experience, prior experiences with mathematics, beliefs and attitudes towards mathematics, as well as personality factors. Trujillo and Hadfield (1999) and Williams (1988) suggest that a great number of elementary school teachers are math-anxious. However, the absence of empirical data about the local context makes it impossible for this researcher to make a similar claim about primary school teachers in Trinidad and Tobago. More so, that they are more math-anxious than teachers elsewhere in the world. It is difficult to surmise that they teach mathematics less effectively and avoid mathematical situations more than their non-math-anxious peers. Rather, a more reasonable proposition is that some primary school teachers in Trinidad and Tobago are math-anxious, and some teach mathematics ineffectively or avoid situations that involve mathematics, including teaching mathematics. It may be further suggested that while all primary school teachers experience some degree of mathematics anxiety, they respond to, and manage it in different ways.

The Context

The Ministry of Education of Trinidad and Tobago (MOETT), assert that all children can and must learn, and being unsatisfied with levels of student literacy and numeracy, focused on education reform, which focused on the development, implementation, and revision of a National Curriculum that is undergirded by the constructivist philosophy. For mathematics, this approach sharply contrasts with traditional views of school mathematics as a means of societal stratification on the basis of mathematical ability that afforded certain individuals access to privileges (Atweh, Bleicher & Cooper, 1998; National Research Council, 1989).

The Primary School Context

Trinidad and Tobago is divided into eight educational districts: Caroni, North Eastern, Port of Spain and Environs, South Eastern, St. George East, St. Patrick, Tobago, and Victoria. There are three types of primary and secondary schools in Trinidad and Tobago: government, government-assisted, and private schools. Government and government-assisted primary schools have all enacted the National Curriculum, prepare students for the same national assessments, and are all now fully staffed, equipped and funded by the Government of Trinidad and Tobago (GOTT); however, government schools are completely owned by the GOTT, whole government-assisted schools are co-owned by the GOTT and a denominational (faith-based) board.

Primary schools may be single-sex or co-educational, with government-assisted schools being single-sexed female or male, and government schools comprise both male and female students. Composition aside, government and government-assisted primary schools differ in their admission policy and their religious practices. While government-assisted schools exercise their right to give preferentiality to students of their own denomination, government schools are not permitted to discriminate among the various denominations when admitting students.

The Primary Classroom Context

Primary school teachers have reported that little has changed in the classroom in Trinidad and Tobago. The school day begins around 8:30 am and ends at 3:00 pm. Teachers often remain in their classroom to monitor their students for the whole day, with little time for preparation or relaxation during the day. They are assigned to one class from Infants I to Standard 5, and teach all the subjects that form the National Curriculum. These subjects include mathematics, science, language arts, physical education, social studies, and art. The school day is divided among these subjects, and teachers are required to teach mathematics for up to four hours per week, regardless of their competence, confidence, or desire to do so.

Teachers have complained that the class size in many schools exceeds 30 students, and classes sometimes occupy cramped and poorly ventilated rooms. Sometimes several classes occupy a large room that has been partitioned to accommodate them. Teachers report that classes are typically arranged so that students sit in rows of benches built for two, and face the teacher who sits at the front of the class. Further, instruction typically involves simultaneously introducing the whole class to mathematical concepts, after which students engage in individual seatwork assigned from a textbook or workbook. Thus, learning relies on the teacher's explanation and demonstration, and students observe and replicate the mathematics their teacher does.

The Primary School Teacher

In Trinidad and Tobago primary school teachers vary in age from 18 to under 60 years, the majority of which are female. They may or may not reside in the communities within which they work. Those who work in remote communities sometimes complain that they encounter challenges getting transportation to and from work, which is sometimes costly to them. None of these teachers possess pre-service teacher training since this is not a requirement for employment by the MOETT. Some teachers report that their highest level of education is secondary school certification. Others report that they possess an in-service Certificate in Education, Teachers College Diploma, and/or Bachelor of Education. Further, unlike their colleagues in secondary school, primary school teachers do not specialize in teaching mathematics.

Recruitment of Primary School Teachers

Individuals have entered the teaching service in Trinidad and Tobago's history through various routes. It is reported that in the past, before secondary education became more accessible, exemplary primary school students were recruited as primary school teachers. These students had demonstrated the desired potential and disposition to be teachers, and became "apprentices" of their own teachers. Some of theses individuals are still teaching today. Later on, as more individuals accessed secondary education, employment opportunities became contingent upon successful completion of Ordinary Level examinations, which need not have included mathematics. Thus, some primary school teachers report that their last experiences of "doing" mathematics were their third year in secondary school.

Today, however, recruitment practices of the MOETT have changed. In the 1980s, Ordinary level mathematics and science became required qualifications for employment. This aside, there are some differences between how teachers are appointed to government and government-assisted schools. Some government-assisted schools to recruit their teacher, and then assist them with gaining formal employment with the MOETT through the Teaching Service Commission of Trinidad and Tobago (TSC). The school's denominational board pays these individuals until they are formally appointed to the school that recruited them. On the other hand, all teachers at government schools are recruited and appointed by the TSC. However, all potential teachers are subject to the same interview, selection, and appointment process of the TSC.

Training of Primary School Teachers

Teachers report that there are limited professional training opportunities currently available in Trinidad and Tobago. They add that there are no tangible incentives to lure them to pursue these opportunities, beyond for personal satisfaction. Unfortunately, until four years ago primary school teachers with at least two years of continuous service were given a scholarship to Teachers College for in-service training. The two-year programme proposed to expose in-service teachers to courses in mathematical methods and pedagogy to equip them to teach mathematics effectively. This practice presumed that training produced teachers who were knowledgeable about modern approaches to mathematics instruction.

However, some graduates of these programmes lament that this training did not help them develop the mathematical content knowledge and competencies required to effectively teach mathematics, particularly in the absence of follow-up and continued support. Cuff (1993) offers that teacher educators often ignore the problem of mathematics anxiety. They instead focus on teaching content because it is easier and more familiar.

Arguably, there is no empirical evidence to attest that teacher education programmes in Trinidad and Tobago have responded to the training needs of primary school teachers, particularly with respect to teaching mathematics. One may thus conjecture that primary school teachers are confined by a limited repertoire of effective instructional strategies for mathematics, and question their ability to provide meaningful learning experiences for their students. One may further speculate that since they have experienced predominantly teacher-centered mathematics instruction at primary school, they are more likely to mirror their own teachers' beliefs, attitudes, and approaches to mathematics instruction. One may even surmise that their exposure to ineffective teaching practices of their own teachers may impact upon their efficacy in teaching mathematics. Therefore, concerns arise about the soundness of content knowledge, conceptual understanding of mathematical concepts, and pedagogical competencies of primary school teachers.

It is disconcerting to this researcher that despite growing national concerns about student under-achievement in mathematics, there is a dearth of research into the teacher-related factors that influence student performance, in particular, the primary school teachers' mathematics anxiety. However, simply identifying a teacher as math-anxious does not elucidate the contributing factors of that anxiety, but merely indicates of the presence of the anxiety (Taylor & Fraser, 2003); nor does it guarantee that teachers will not transfer their anxiety to their students, affecting their students' achievement in, and attitudes towards mathematics (Emenekar, 1996). In fact, in the absence of research, there is no evidence that mathematics anxiety is even a contributing factor in the mathematics teaching and learning environment. Hence, research in this area is imperative in Trinidad and Tobago.

The Problem Statement

The impact of mathematics anxiety on teachers' performance and efficacy has been under-researched in Trinidad and Tobago. The resulting dearth of empirical data makes it difficult to make inferences about the extent to which mathematics anxiety among primary school teachers' impacts upon the teaching and learning environment.

The Purpose of the Study

The purpose of this study was to clarify the relationship between mathematics anxiety, teacher efficacy for teaching mathematics, and mathematics avoidance among primary school teachers in

Trinidad and Tobago.

The Research Questions

The study sought to answer the following questions as they pertain to mathematics anxiety and primary school teachers in Trinidad and Tobago:

1. Is there a difference in
    a. mathematics anxiety and teacher variables of gender, age, highest level of education, and number of years of teaching experience?
    b. mathematics teacher efficacy and teacher variables of gender, age, highest level of education, and number of years of teaching experience?
    c. mathematics avoidance and teacher variables of gender, age, highest level of education, and number of years of teaching experience?
2. Is there a relationship between mathematics anxiety, beliefs about efficacy in teaching mathematics, and teachers' mathematics avoidance?

Significance of the Study

The issue of mathematics anxiety continues to receive much international attention as researchers strive for clearer understanding of factors that contribute to its prevalence, its impact on mathematics teaching and learning, and on teachers' beliefs and attitudes towards mathematics. Much of this research has focused on pre-service elementary teachers. This creates a void in the literature about a significant subset of math-anxious individuals – practicing primary school teachers. Further, research about mathematics anxiety has not been mirrored locally further widening the gap in what is known about how mathematics anxiety impacts upon classroom instruction. This information may be instructive to policy makers about recruitment criteria for teachers, as well as training requirements for practicing primary school teachers Trinidad and Tobago.

Research about mathematics anxiety is importance in light of the renewed international thrust in science, technology, and mathematics. This has significant implications for Trinidad and Tobago, which continues to rely heavily on the energy sector and its related field for economic viability. It is thus critical that individuals become competent and confident in their ability to do mathematics (Furner, Yahya, & Duffy, 2005). Hence, this study proposes to add to the scholarly research in education in the Caribbean, and in particular, to present empirical data about mathematics anxiety and its impact on the teaching and learning of mathematics in primary classrooms in Trinidad and Tobago.

The empirical data that this research generates about the local context could inform teacher educators who develop and implement teacher education programmes in mathematics and science. Teacher education and preparation ought to be driven by empirical data that specifically address relevant issues. Thus, research about mathematics anxiety would allow teacher educators to design appropriate programmes for teachers that equip them with the skills to their manage mathematics anxiety, and to increase their effectiveness in teaching mathematics. Hence, this research is critical at this time to enrich the lives of teachers, as well as to improve the classroom experiences of their students.

Delimitations of the Study

The study is delimited in several ways. Firstly, participants are all primary school teachers. Secondly, these teachers teach at government and government-assisted schools. Thirdly, the study takes place in Trinidad and Tobago.

Assumptions of the Study

There are several assumptions upon which this study relies. Firstly, respondents' mathematics anxiety, mathematics teacher efficacy and mathematics avoidance can be measured by a self-reporting questionnaire. Secondly, respondents will understand and interpret the items on the questionnaire in the manner the researcher intended. Thirdly, participants' responses to the questionnaire items accurately reflect their experiences, beliefs, and perceptions. Fourthly, the sample is representative of the population of teachers under study, thus the findings are generalizable to the population.

Operational definitions

Primary school: an educational institution that educates children from age 5 to age 12. (The term elementary school refers to the parallel type of school that exists in other societies, such as the United States of America.)

Government primary school: a primary school that is fully owned by the MOETT.

Government-assisted primary school: a primary school that is co-owned by the MOETT and a denominational school board.

Primary school teacher: a teacher who teaches at a primary school. (The term elementary school teacher refers to the teacher who teaches at the same level as primary school teachers, but in other societies, such as the United States of America.)

Mathematics anxiety: an intensely negative emotional reaction to situations that are directly or indirectly associated with mathematics, that appears to threaten an individual's self-esteem (Camen, 1987).

Mathematics teaching anxiety: the anxiety that teachers experience during preparation for teaching mathematics and/or mathematics instruction (Peker, 2009).

Teacher Efficacy: a teacher's judgment of her or his capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated (Armor et al., 1976). ((The term teacher self-efficacy is used synonymously.)

Mathematics teacher efficacy: the personal belief of a teacher in his/her skills and ability to effectively teach mathematics (Gresham, 2008).

Mathematics Avoidance: the tendency to seek escape from dealing with mathematical situations.

Pre-service teacher: a student enrolled in a tertiary institution education programme.

In-service teacher: a practicing classroom teacher enrolled in a tertiary institution education programme.

Chapter Summary

This chapter introduced the purpose of the study, namely the relationship between mathematics, teacher efficacy in the teaching of mathematics, and avoidance behaviours of primary school teachers. It provided the research questions that this study sought to answer in order to address the problem that was identified. It also attempted to contextualize the nature of teaching at the primary school level, in order to highlight the significance of researching the phenomenon of mathematics anxiety in Trinidad and Tobago.

Organization of the Report

Following this chapter is a review of the literature related to mathematics anxiety, teacher efficacy beliefs, and mathematics avoidance behaviours, in order to locate the local context within the global context. Chapter 3 follows the literature review, and outlines in detail the research design and methodology for data management, which was undertaken during this research process. This is followed by the presentation of the findings in Chapter 4. The report concludes with a discussion about the nature and implications of the findings, from which inferences and recommendations were offered, including recommendations for future research about mathematics anxiety.

CHAPTER 2 – Review of Research and Literature

Introduction

This chapter reviews the literature on mathematics anxiety that has emerged since the 1960's, as well as the related constructs of mathematics teaching anxiety, mathematics teacher efficacy, and teachers' mathematics avoidance. The discussion begins with an introduction to attitudes towards mathematics and a definition of mathematics anxiety. It continues with an exploration of some teacher-related causes of mathematics anxiety, and its effects in the classroom. The review then explores the link between mathematics teaching anxiety and mathematics teacher efficacy, and how they impact upon the classroom environment and student attitudes, beliefs, behaviours, and performance in mathematics. Finally, the chapter concludes with an examination of the classroom-related factors that contribute to mathematics anxiety of students

Attitudes towards Mathematics

For many years there has been increasing concerns about students' falling achievement in mathematics and their negative attitudes towards mathematics, despite its importance in the world today (Gresham, 2007; Malinskey, Ross, Pannells & McJunkin, 2006). Some educators believe that individuals develop attitudes and emotional reactions towards mathematics from as early as 9 years old (McLeod, 1993), which are seldom ambivalent; rather, they are either positive or negative, with negative attitudes persisting well into adulthood (Brady & Bowd, 2005). Research into the factors that impact upon individuals' success in, and attitudes towards mathematics point to mathematics anxiety as one of them (Shores & Shannon, 2007).

Biggs (1965, as cited in Brown, 1983) suggests that learning mathematics arouses strong emotions, particularly anxiety, more readily than other school subjects. Others add that anxiety about mathematics and doing mathematics greatly influences students' mathematics performance and achievement (Hembree, 1990; Richardson & Suinn, 1972; Suinn, Edie, Nicoletti, & Spinelli, 1972), and their attitude towards mathematics. However, much of the ongoing research on mathematics anxiety has focused on adolescents, college-aged students and pre-service elementary school teachers. Substantial empirical evidence suggests that pre-service elementary school teachers are among those individuals who are most math-anxious (Bursal & Paznokas, 2006; Kelly & Tomhave, 1985). However, there is no parallel evidence about currently practicing teachers at the primary level in the Caribbean or in Trinidad and Tobago. As such, this study proposed to explore mathematics anxiety among primary school teachers in Trinidad and Tobago to close the gap that exists in the local context.

A Definition of Mathematics Anxiety

Anxiety is a complex emotional response, which has behavioural, psychological, affective, physiological, and cognitive aspects that impede an individual's ability to "constructively manage challenges, problems and opportunities" (Kellerman & Burry, 2007, p.77). Though anxiety is often confused with fear, which is a response to an actual stimulus or threat, anxiety is a response to an anticipated stimulus or threat. Thus, an individual who faces a situation they perceive of as immediately threatening goes into fight-or-flight mode in preparation for action. They become agitated or anxious about the situation and experience mental and physical manifestations of their unease, such as sweating, tension, and increased heart rate (Anxiety Disorders Association of America, 2010), often appearing to respond irrationally to stimuli that others may not interpret as threatening. Anxiety-prone individuals often cannot distinguish between fear and anxiety. It is therefore natural that all individuals experience anxiety at some time in their lifetime.

Though there are many forms of anxiety the one that is related to mathematics is referred to as mathematics anxiety. In 1972, Richardson and Suinn described mathematics anxiety as “feelings of tension and anxiety that may interfere with manipulation of numbers and solving of mathematical problems in a wide variety of ordinary life and academic experiences” (p.551). Ma (1999) suggests that mathematics anxiety is a multidimensional construct that comprises attitudinal, cognitive and emotional dimensions – a learned response (Johnson, 2003; Austin, Wadlington, & Bitner, 2001), which interferes with conceptual thinking and memory processes (Ashcraft, 2002; Skemp, 1986) and causes individuals to forget the mathematics they know and to lose their self-confidence (Tobias, 1993).

Richards and French (1990) suggest that anxiety causes individuals to selectively process information. They focus on apparently threatening and irrelevant bits of information rather than the whole. Ashcraft and Faust (1994) suggest that this reduces task performance, by unduly taxing cognitive resources. Camen (1987) described it as a state of anxiety induced by exposure to situations involving mathematics that appear threatening to self-esteem. It may even inhibit mental efficiency of individuals who demonstrate high intellectual mathematical potential otherwise (Kennedy, 1971).

More than a dislike of mathematics (Vinson, 2001), mathematics anxiety is rooted in emotional and cognitive fear of mathematics (Tobias, 1978). It causes individuals to develop negative perceptions and attitudes about mathematics and their ability to perform mathematical tasks, and often leads to outright avoidance of mathematics (Tobias, 1987). Simply put, mathematics anxiety as an intensely negative emotional reaction to anything related to mathematics (Ashcraft, Krause & Hopko, 2007; Kennedy & Tipps, 1990). It must be noted though that not every individual who experiences mathematics anxiety will become debilitated by it. There are those who are able control the anxiety and channel the energy into performing the task with some degree of success.

Smith (1997) posits that the onset of mathematics anxiety is evident in the way individuals react in mathematical situations. These include uneasiness when asked to perform mathematical tasks; avoidance of attending mathematics classes until the last moment; the experience of physical illness, faintness, dread or panic; the inability to perform on mathematics tests; and participating in tutoring which yield little success. Wright and Miller (1981) posit that an individual's mathematics anxiety is directly related to how the individual ranks his/her mathematical ability in comparison to other subject areas.

However, Sousa (2008) argues that ability to achieve in mathematics does not cause the anxiety. It is poor conceptual understanding of mathematical concepts and the over-reliance of procedural understanding when engaging in mathematical problem solving. Low conceptual understanding of mathematics replaces mathematical prowess with disdain for, or fear of mathematics, which when left unchecked, morphs into anxiety about mathematics and doing mathematics (Hembrees, 1990).

Teacher-related Causes of Mathematics Anxiety

Trujillo and Hadfield (1999) categorized the causes of mathematics anxiety into personality factors, environmental factors, and intellectual factors. Personality factors include an individual's unwillingness to ask questions and his/her low self- esteem. Environmental factors include negative classroom experiences with mathematics, parent and teachers' attitudes towards mathematics, and mathematics instruction. Intellectual factors include students' attitude, lack of confidence in mathematical ability, misalignment of student learning styles and teaching strategies, and the perceived lack of utility of mathematics. However, the perceived abstract nature of mathematics (Orton & Frobisher, 1996; Brush, 1981), the precision and logic that is required, and the emphasis on problem solving may also contribute to mathematics anxiety (Richardson & Wookfolk, 1980). Perry (2004) suggests that past repeated, negative experiences with teachers may also contribute to an individual's mathematics anxiety (Raymond, 1997), from as early as elementary or primary school (Jackson & Leffingwell, 1999; Tankersley, 1993).

Swars, Daane and Giesen (2006) found that pre-service teachers with high mathematics anxiety identified timed tests and pop quizzes as negative experiences with mathematics, because they required memorization of procedural knowledge. On the other hand, teachers with low mathematics anxiety identified having a supportive parent, and having experiences in mathematics that emphasized a problem solving, reasoning, and communication. Teachers' attitudes (Sousa, 2008) and approaches to mathematics instruction (Uusimaki & Nason, 2004; Furner & Duffy, 2002; Trujillo & Hadfield, 1999; Cornell, 1999; Dossel, 1993; Tobias, 1993; Williams, 1988) hinder students' learning (Scarpello, 2007) and facilitate the development of students' mathematics anxiety in various ways.

These include teachers' assumptions that mathematical processes and procedures are simple and self-explanatory; their the use of mathematical vocabulary without sufficient definition; their over-reliance on traditional strategies such as drill-and-practice; their linear approach to mathematics instruction that may leave students behind if they did not grasp earlier concepts; assigning the same problem to every student; their overemphasis on rote learning; the presentation of mathematics as a fixed body of rules; and the isolated way in which mathematics is taught, without connection to other disciplines or the real world.

Other classroom experiences include teachers' derogatory remarks about students in the presence of their peers (Johnson, 2003; Jackson and Leffingwell, 1999); overt impatience with, and hostility and insensitivity towards students who needed attention or who did not immediately grasp a concept after the initial explanation (Brady & Bowd, 2005); unreasonably high expectations of students (Haylock, 2003); highlighting students' errors to the entire class; and gender bias towards boys (Shields, 2005). The latter behaviour involved ridiculing girls more often than boys, and providing less support and assistance to girls over boys (Brady & Bowd, 2005).

Gender stereotypes about mathematics have held strong, even today. There continues to exist the assumption that mathematics is more difficult for girls than for boys (Smith & White, 2002). Research into to link between mathematics anxiety and observed differences in mathematics performance and achievement between females and males (Tobias & Weissbrod, 1980; Fennema, 1977; Fox, 1977) has revealed no significant difference between the genders (Shields, 2005; Richardson & Suinn, 1972; Resnick, Viehe & Segal, 1982; Tocci & Engelhard, 1991). Educators have cautioned teachers against propagating this stereotype (Smith & Smith, 2007; Shields, 2005; Johnson, 2003).

Swetman (1994) adds that teachers who hold negative attitudes towards mathematics inadvertently communicate and transfer this anxiety to their students, perpetuating negative attitudes towards mathematics, including mathematics anxiety (Uusimaki & Nanson, 2004; Ma, 1999; Hembree, 1990). However, when teachers model positive attitudes towards mathematics, it positively impacts upon their students' attitude towards mathematics, their belief in the utility of mathematics, and their confidence in their own efficacy for doing mathematics (Shields, 2005).

Students' Mathematics Anxiety

Learning mathematics is emotional and intellectual (Tobias, 1977). A major problem for many individuals is their lack of confidence in their mathematical ability (Trujillo & Hadfield, 1999), which can often be traced to their mathematics anxiety; whether a result of it or the cause of it (Shores, 2005). Lack of confidence to do mathematics triggers an emotional block against learning and doing mathematics, and may lead to complete paralysis in the thinking process (Shores, 2005), as a math-anxious individuals attempts to save-face in the presence of peers and colleagues. This further inhibits learning and hinders conceptual understanding of mathematical concepts, further decreasing the individual's confidence and increasing their mathematics anxiety. Ma (1999) reported a significance inverse relationship between mathematics anxiety and mathematics performance, and concluded that mathematics anxiety decreases with improved mathematics performance of a math-anxious teacher.

Shores and Shannon (2007) reported that students' performance on mathematics tests and their mathematics grades were negatively correlated to their mathematics anxiety, meaning that as mathematics anxiety increases, mathematics achievement decreases. They further report that highly efficacious students outperform their peers with low self-efficacy in mathematics. They suggest that highly math-anxious students were less prepared for mathematics class and expected failure, unlike their peers with low mathematics anxiety. They too, concluded that mathematics anxiety impedes the learning of mathematics and hinders conceptual understanding of mathematical concepts. Waddlington and Bitner (2001) and Peterson, Burton, and Baker (1983) concluded that mathematics teachers greatly influence students' self-concept in mathematics, and can cause their students to have low mathematics self-concepts by creating negative experiences in the classroom.

Mathematics Teaching Anxiety

Mathematics anxiety has been linked to the teacher and the teaching of mathematics (Malinsky, Ross, Pannells & McJunkin, 2006; Furner and Duffy, 2002; Williams, 1988). As a result, rrecent research about mathematics anxiety has been broadened to include research into pre-service and in-service teachers' mathematics teaching anxiety (Peker, 2009). Gardner and Leak (1994) and Levine (1993) described mathematics teaching anxiety as the anxiety that teachers experience during lesson preparation, and during instruction when they teach "mathematical concepts, theories and formulas or during problem solving" (as cited in Peker, 2009). This anxiety can be linked to teachers' 'content knowledge, pedagogical knowledge, attitudes towards mathematics and self-confidence related to both mathematics anxiety and mathematics teaching anxiety' (Peker, 2009). Manifestations of teacher mathematics anxiety include feelings of tension; heightened nervousness; difficulty in concentrating, especially in noisy environments; extreme agitation at students; and negative self-talk (Levine, 1999). Negative self-talk in particular, may reduce a teacher's self-confidence to teach mathematical concepts because they become convinced that they cannot do so competently (Godbey, 1997).

Pre-service elementary teachers have attributed their mathematics anxiety to their negative experiences with mathematics as students, and to their teachers' attitudes and methods of instruction (Gresham, 2007; Malinsky, Ross, Pannells, & McJunkin, 2006; Brady & Bowd, 2005; Uusimaki & Nason, 2004; Vinson, 2001; Vinson, Haynes, Brasher, Sloan & Gresham, 1997; Austin, Wadlington & Bitner, 1992). While it may be true that a substantial number of pre-service elementary school teachers are math-anxious (Alsup, 2003; Malinksy et al, 2006;), and they often hold negative attitudes towards mathematics (Vinson, 2001; Hembree, 1990), the same may not be necessarily true of all primary school teachers in Trinidad and Tobago.

Math-anxious teachers who hold negative attitudes about their teaching of mathematics tend to have a poor understanding of mathematical concepts and poorly developed problem solving competencies (Cohen & Green, 2002), thus they cannot teach what they do not know. They view mathematics as a set of compartmentalized facts and rules that are to be memorized once acquired (Ball, 1996). They do not understand how students learn mathematics, and so are unable to identify and assist students who experience difficulty in mathematics (Harper & Daane, 1998; Kennedy, 1998). They do not know how to listen to their students, thus they do not know what students think about mathematics, or how to encourage them to share what they think (Kennedy, 1998). The generally find it difficult to cope with their fear of mathematics. This ought to raise serious concerns about teachers' ability to effectively teach mathematics to young children (Trice & Ogden, 1986; Teague & Austin-Martin, 1981), and the likelihood that they will communicate and transfer their anxiety to their students (Gresham, 2008; Uusimaki & Nason, 2004; Austin, Wadlington, & Nitner, 2001; Swetman, 1991; Kelly & Tomhave, 1985).

Swars et al. (2006), Vinson (2001) and Hembree (1990) posit that math-anxious teachers tend to employ traditional teaching strategies such as lecturing, rather than collaborative strategies. They spend more time on whole group instruction, rather than differentiated instruction. Math-anxious teachers rely heavily on mathematics textbook to direct instruction;

promote rote memorization; teach for skills acquisition rather than conceptual understanding of mathematical concepts. They assign the same work to all students, rather than meeting the needs of diverse learners in the classroom. They emphasise solving textbook problems and algorithmic problem solving (Alsup, 2003), rather than spending time on problem solving activities and linking mathematical concepts to the real world; are less confident about teaching mathematics (Bursal & Paznokas, 2006; Brady & Bowd, 2005); and have low mathematics teaching efficacy (Swars, Daane & Giesen, 2006). Swars (2004) found that elementary teachers with low mathematics anxiety were highly efficacious teachers.

Teacher Efficacy

The construct of self-efficacy can be traced to the social cognitive theory of Bandura (1994), who deconstructed self-efficacy into two behavioural constructs: efficacy expectations and outcome expectations. Efficacy expectations refer to an individual's personal belief that she/he has the 'capabilities to organize and execute the courses of action required to produce given attainments' (Bandura, 1997, p. 3). On the other hand, outcome expectation is an individual's personal belief that a particular behaviour will yield a specific outcome (Swars, 2007).

However, this explanation of efficacy does not refer to an individual's actual abilities to perform a task, but her/his perceived ability to perform the task. Thus, two individuals with the same skills or abilities may experience different levels of success at the same task, depending on the beliefs about their own efficacy for performing the task. It is the combination of positive self-efficacy, skills and knowledge that are required for performing a given task (Huinker & Madison, 1997). Bandura (1986) and Pajares (1996) attribute efficacy beliefs to an individual's previous experiences, which are specific to situations and contexts.

Bandura (1997) elaborated on four factors that develop efficacy. He suggests that teachers' mastery experiences strengthen efficacy, particularly when an appropriately challenging task is successfully completed with little assistance. On the other hand, vicarious experiences allow individuals to observe and assess the success of others whose abilities may or may not match theirs, and may affect efficacy beliefs. Bandura also suggests that social persuasion may strengthen teachers' efficacy beliefs when others express confidence in them. Finally, Bandura suggests that positive emotional and physiological environment builds efficacy.

A related construct, teacher efficacy, is defined as 'teachers' beliefs in their ability to actualize the desired outcomes' (Wheatley, 2005, p. 748), and has attracted much research over the last three decades. Tschannen-Moran and Hoy (2001), Ross (1992) and Ashton and Webb (1986) discovered a strong positive correlation between teachers' self-efficacy beliefs, effective teaching practices and improved student achievement. Teacher efficacy beliefs affect the way teachers feel about their work. They begin to take shape early in the learning process, and once 'established they appear to be somewhat resistant to change' (Hoy, 2000, p. 5), and have implications for teacher development early in a teacher's career (Hoy, 2004).

For new teachers, it must be challenging to teach in a way that is at odds with their own experiences as students, particularly if these experiences and successes were dominated by teacher-centered approaches (Huinker & Madison, 1995). Overcoming their self-doubt in this situation is often worsened if these individuals were successful at traditional mathematics, at which they have attained some proficiency, but are required to engage in constructivist strategies to teach their students.

Hoy and Spero (2005) found that the decline in pre-service teacher efficacy during their first year of teaching was due to an underestimation of the complex nature of teaching during their time as student teachers, and the inadequate support they received once they began teaching. However, teaching experience increases teacher efficacy (Wenner, 2001), although Ross (1994) reported that teacher efficacy declined when they taught higher grades. It is unclear however, if teacher efficacy beliefs are gender related. Some researchers suggest that female teachers have higher efficacy beliefs than their male colleagues (Cheung, 2006; Evans & Tribble, 1986), while others have found no such relationship exists (Ghaith & Shaaban, 1999; Hoy & Woolfolk, 1993).

Research suggests that high efficacy in teachers positively influences their attitudes towards their work (Coladarci, 1992), and their persistence in managing related challenges (Soodak & Podell, 1993). Teachers with high self-efficacy possess and experiment with a wide repertoire of instructional strategies that are student-centered (Czerniak, 1990; Enon, 1995; Riggs & Enochs, 1990; Wenta, 2000), especially strategies that require them to negotiate control with their students (Hami, Czerniak, & Lumpe, 1996) and manage their classrooms (Woolfolk, Rosoff, & Hoy, 1990). They are more likely early adopters of innovations; take time to plan their lessons (Allinder, 1995); are more committed to teaching and to their students (Swars et al., 2006).

Efficacious teachers persist in their efforts with students who are struggling (Gibson & Dembo, 1984) and positively influence their students' motivation (Perry, 2004; Midgley, Feldlaufer & Eccles, 1989) and academic achievement (Guskey, 1988; Gibson & Dembo, 1984; Ashton, Webb, & Doda, 1983). These teachers experience lower levels of mathematics anxiety than teachers with a low sense of self-efficacy. Conversely, Bandura (1997) suggests that teachers with low efficacy tend to set goals that they do not complete, become less interested in completing tasks, become less motivate over time, and view themselves as less competent than their peers.

Mathematics Teacher Efficacy

Mathematics teacher efficacy may be described as teachers' beliefs that they can effectively teach mathematics to all students in a way that they can learn, regardless of external influences such as external factors such as students' home environment or family background. Swars et al. (2006) found a negative relationship between pre-service elementary teachers' mathematics anxiety and efficacy beliefs; however, this negative relationship was only found with respect to efficacy expectations. There was no relationship between mathematics anxiety and outcomes expectations. Thus, while the teachers with low mathematics anxiety believed that they were highly effective mathematics teachers, they could not predict whether effective teaching could bring about learning.

Swars et al. however pointed out that their findings contradict the findings of Hoy (2000) and Hoy and Woolfolk (1990), who found that pre-service teachers generally overestimated their abilities to bring about student learning in spite of negative external influences. They also cautioned that some researchers expressed concerns about the meaning and interpretation of the outcomes expectation subscale, since teacher efficacy may be influenced by an unclear distinction between expected outcomes based on teachers' performance, external influences or teachers' external locus of control.

Swars (2007) and Brady and Bowd (2005) reported that pre-service elementary teachers' past mathematical experiences influenced their efficacy beliefs. Teachers recalled that they could not cope with the pace of the mathematics instruction while at school, and they felt inadequate and discouraged when their teachers grew impatient with their inability or slowness to internalize and understand mathematical concepts, which they attributed to their feelings of under-preparedness to teach mathematics. Despite this, Swars et al. (2006) found that even teachers with high mathematics anxiety indicated that their negative past experiences with mathematics enabled them to be more effective mathematics teachers because they empathize with their students' struggles with mathematics. Trujillo and Hadfield (1999) found that pre-service teachers felt that they could divorce themselves from their mathematics anxiety and eventually become effective mathematics teachers.

Research has repeatedly linked teachers' mathematics anxiety and their ability to effectively teach mathematics, making the need for research into the relationship between mathematics teacher anxiety and mathematics teacher efficacy even more pertinent (Swars, et al., 2005). Further, Bandura (1986) argues that building an individual's efficacy beliefs requires addressing their anxiety, since their beliefs about their efficacy depend on their emotional state at the time. Teachers who lack a sound grounding in mathematical concepts struggle to plan and deliver effective mathematics lessons (Goulding, Rowland & Barber, 2002). Teachers who are trained to teach mathematics tend to be more committed and passionate about teaching the subject, and are likely more efficacious at doing so (Laturner, 2002).

Mathematics Teaching Anxiety, Teacher Efficacy and Mathematics Avoidance

Mathematics anxiety is the driving force behind mathematics avoidance. Though some degree of anxiety can be motivating and exciting, beyond a tolerable level it may cause an individual to attempt to escape from the situation. Tobias (1978) suggests that individuals develop mathematics avoidance because of attitudes they develop towards mathematics due to negative early educational experiences. Pries and Biggs (2001) described the cyclic nature of mathematics avoidance, which begins with an individual experiences negative reactions to a mathematical situation, usually based on prior negative experiences with mathematics. The individual then completely avoids any mathematical situations, including preparing for mathematics in the classroom, which in turns leads to poor performance in mathematics, adding to the negative experiences or associations with mathematics and leading to further avoidance of mathematical situations. Enough repetitions of this cycle convince the individual that they simply cannot do mathematics, and requires drastic measures to convince them otherwise and break the cycle.

Researchers like Hembree (1990), Ma (1999), Mantey (2007), Nicalaou and Phillipou (2007), Seaman (1999), and Tobias and Weissbrod (1980) suggest that mathematics anxiety influences individuals in their study and career choices. Highly math-anxious individuals tended to avoid courses of study and careers that required mathematics. Kelly and Tomhave (1985) reported that female pre-service elementary teachers were more math-anxious than their male counterparts, and engaged in more mathematics avoidance behaviours than other college students. Kelly and Tomhave (1985) and Tobias (1978) suggested that some individuals deliberately chose to teach at the elementary level because they perceive that less mathematics will be required of them there. However, this perception was quickly reversed when they realized the amount of mathematical knowledge required to effectively teach mathematics. Kelly and Tomhave (1985) warn that this tendency is of great concern since most elementary teachers are female and may be passing on mathematics anxiety to their students, particularly the females. Trice and Ogden (1986) add that highly math-anxious teachers often avoid teaching mathematics whenever possible.

Summary

The literature on mathematic anxiety identifies it as a relatively complex construct that once formed, is difficult to alter. In an attempt to understand it, researchers have examined the factors that contribute to its development in individuals, as well as how it is related to other constructs. The literature suggests that strongly held views about mathematics, including mathematics anxiety, develop in the formative years of schooling and impacts upon the teaching and learning environment. Individuals' personal classroom experiences with mathematics and teachers influence their attitudes and beliefs about mathematics, their confidence to do mathematics, and their mathematics performance and achievement.

Mathematics anxiety has been examined in conjunction with other constructs like mathematics efficacy and mathematics avoidance, with an emphasis on pre-service elementary school teachers. These individuals also attribute their mathematics anxiety to their early classroom experiences with mathematics, and emphasize their teachers' attitudes and instructional practices as major factors. The literature suggests that highly math-anxious pre-service teachers are less confident about their ability to teach mathematics and hold low expectations about their teaching in the future. They teach mathematics less effectively than their low math-anxious peers, and tend to avoid mathematical situations whenever possible, including teaching mathematics. More often than not, they transfer their anxiety to their students.

Research about mathematics anxiety has focused on measuring its prevalence among students and pre-service elementary school teachers, identifying the factors that cause it, and establishing a relationship between mathematics anxiety and teacher efficacy and confidence to teach mathematics. These findings have predominantly reflected the European and American contexts. There is little evidence of similar research efforts in the local context, particularly in light of major differences between these societies and Trinidad and Tobago. Some of the differences exist in the mathematics curricula, school structure, and policies regarding the recruitment and training of primary school teachers. For one thing, the fact that pre-service training is not available for primary school teachers in Trinidad and Tobago means that all teachers here enter the service untrained, which has implications for the teaching and learning environment that have not been explored in this context.

The literature on mathematics anxiety has not sufficiently explored the extent to which the teacher-related variables of gender, age, length of time teaching, and highest level of educational achievement may bear on mathematics teaching anxiety, particularly in the local context. These variables may also have some bearing on teachers' beliefs about their ability to teach mathematics effectively, and the extent to which they attempt to avoid mathematics. This study proposes to explore these relationships in order to address the gaps in the literature regarding the local context.

Chapter Summary

This chapter presented a review of some of the existing literature on mathematics anxiety, mathematics teacher anxiety and mathematics teaching efficacy, and mathematics avoidance behaviours that were explored in this study. A discussion and definition of mathematics anxiety, some of its possible teacher-related causes and its effects in the classroom, introduced the chapter. Then, the relationship between mathematics teaching anxiety and mathematics teacher anxiety, and how they impact upon the classroom environment and student attitudes, beliefs, behaviours and performance in mathematics was explored. This was followed with a discussion about how mathematics teacher anxiety and teaching efficacy are linked to mathematics avoidance behaviours displayed by teachers. The conclusion of the review explored some classroom-related factors that contribute to mathematics anxiety of students.

The following chapter outlines the methodology for the study that was undertaken, the results of which were analyzed with reference to the concepts explored in the literature in this chapter.

CHAPTER 3 – Methodology

Introduction

This chapter addresses the research methodology that was employed in this study on mathematics anxiety among the primary school teachers in Trinidad and Tobago. It begins with a restating of the problem being investigated, the purpose of the study, and the research questions. The chapter continues with description of the research design, the population and sample, and the sampling strategy. A detailed description of the data collecting instruments as well as the data collecting process is then followed by the presentation of the data management and analysis techniques employed in the study. The chapter concludes with the limitations of the study.

The Problem Statement

The impact of mathematics anxiety on teachers' performance and efficacy has been under-researched in Trinidad and Tobago. The resulting dearth of empirical data makes it difficult to make inferences about the extent to which mathematics anxiety among primary school teachers' impacts upon the teaching and learning environment.

The Purpose of the Study

The purpose of this study was to clarify the relationship between mathematics anxiety, teacher efficacy for teaching mathematics, and mathematics avoidance among primary school teachers in Trinidad and Tobago.

The Research Questions

The study sought to answer the following questions as they pertain to mathematics anxiety and primary school teachers in Trinidad and Tobago:

1. Is there a difference in
    a. mathematics anxiety and teacher variables of gender, age, highest level of education, and number of years of teaching experience?
    b. mathematics teacher efficacy and teacher variables of gender, age, highest level of education, and number of years of teaching experience?
    c. mathematics avoidance and teacher variables of gender, age, highest level of education, and number of years of teaching experience?
2. Is there a relationship between mathematics anxiety, beliefs about efficacy in teaching mathematics, and teachers' mathematics avoidance?

Research Design

This study employed quantitative methods in the form of a survey design technique to (a) identify the relationships that exist among mathematics anxiety, mathematics teaching efficacy and mathematics avoidance of primary school teachers; and (b) to determine if there are differences in teachers' self-reporting on their mathematics anxiety, mathematics teacher efficacy, and mathematics avoidance in terms of their gender, age, years of teaching, and highest level of educational attainment. While this approach may not provide the holistic understanding of mathematics anxiety that a mixed method design may provide (McMillan & Schumacher, 2006), the quantitative research method provides a general understanding of the phenomenon being investigated.

Quantitative analysis will be used to establish interrelationships between and among variables (Cohen, Manion & Morrison, 2000), and to determine the direction and the magnitude of relationship among these variables. Inferential statistics will be used to indicate differences within and among the groups surveyed. Notably, while quantitative research is considered systematic and objective in nature, it is prone to the subjectivity and changing nature of the human experience, thought, memory, and interpretation (Clandinin & Connelly, 2000) of the participants involved.

The Population and Sample

The population which this sample generalized consisted of all primary school teachers employed by the Ministry of Education of Trinidad and Tobago, and included teachers at government and government-assisted primary schools in Trinidad and Tobago. Teachers who teach at privately owned primary schools were not considered in this study because of the recruitment practices at these institutions, which vary significantly from those of the MOETT, and which could not be controlled.

The sample comprised 68 primary school teachers in Trinidad and Tobago who varied in age, academic and professional qualifications, gender, school type and educational district. Their ages ranged from 30 to 58 years. They represented six of the eight educational districts, with Victoria and Tobago not being represented. There were both female and male teachers in the sample, and all worked at either government or government schools in Trinidad and Tobago, and they had been teaching from as little as three months to 35 years. They all taught a single class of students that ranged from Infants I to Standard 5. Primary school teachers are all expected to teach mathematics.

The sample was selected using a non-probability sampling strategy. The following criteria were used to select the sample. The teachers in the sample

(i) were currently teaching at a government or government-assisted primary school in Trinidad and Tobago;

(ii) were teaching the National Curriculum of Trinidad and Tobago;

had attained the required certification at CSEC level;

and had been subjected to, and satisfied the recruitment procedure of the Teaching Service Commission of Trinidad and Tobago; and

(iii) had agreed to participate in the study.

Sampling Procedures

This study utilized a non-probability purposive sampling strategy to select a sample from the population under study. This strategy allowed the researcher to conveniently, economically (Descombe, 1998), and purposefully accesses the target sample of primary school teachers who met the criteria for sample selection outlined previously (Black, 1999; Paton, 1990). One of the limitations of this strategy is that it may produce a sample that is non-representative of the population (Castillo, 2009); however, this researcher believed that the initial participants approached were representative of the population regarding all the demographics identified above (Dane, 1990). Further, these participants had access to other potential participant who also matched the criteria for selection described previously.

The secondary reason that a purposive sample was utilized in this study is the nature of the study itself. This study is intended to serve as an exploratory study about mathematics anxiety. This will permit the researcher to ‘obtain basic data and trends regarding [the] study without the complications of using a randomized sample' (Castillo, 2009), which are to be investigated more extensively at a later date, utilizing a more substantial portion of the population of primary school teachers in Trinidad and Tobago.

Instrumentation

This study utilized the Mathematics Beliefs Questionnaire (MBQ) to capture quantitative data. The MBQ is a self-reporting survey-type questionnaire that was developed by the researcher for the purposes of this research. The questionnaire comprised two sections. Section A of the MBQ was designed to elicit personal, biographical, and education-related information from the participants. Section B comprised 33 Likert-type items that addressed mathematics anxiety, mathematics teaching efficacy and mathematics avoidance. The full questionnaire may be perused in Appendix B.

Questionnaire Section A – Background Information

Section A comprised questions related to participants' gender; age; highest level of formal mathematics education; highest level of professional training; mathematics grade earned at CSEC; number of years they have been teaching at the primary level; the class they currently teach, and other such information.

Questionnaire Section B – Teacher Beliefs about Mathematics

Section B comprised 33 Likert-type items from the Revised Mathematics Anxiety Scale (RMAS), the Math Avoidance Scale (MAS) and the Personal Mathematics Teaching Efficacy

Beliefs (PMTEB) subscales, which were randomly dispersed throughout the questionnaire. The RMAS and MAS subscales were derived from the Mathematics Experiences Questionnaire (MEQ), while the PMTEB subscale was derived from the Mathematics Teaching Efficacy Beliefs Inventory (MTEBI). A detailed description of each of these subscales follows. The items constituting each of the three subscales of the questionnaire as well as their scoring weights may be perused in Appendix C.

The RMAS and MAS Subscales

The RMAS and MAS subscales were two of five subscales in the MEQ, an instrument initially designed by Allen (2001) to measure each of the constructs of teacher experience, content experience, pedagogy experience, and avoidance behaviours. Its intended use was to “define to define the constructs that potentially affect students' attitudes, feelings, and beliefs with respect to mathematics” (Allen, 2001, p. 47). The MEQ consisted of three other attitude scales: the Pedagogical Experience Scale (PES), the Content Experience Scale (CES), and the Teacher Experience Scale (TES).

The researcher selected the RMAS and MAS subscales because they addressed the constructs of mathematics anxiety and mathematics avoidance, respectively, which were the focus of this study. The researcher believed that since the original developer of these subscales had been piloted and examined them for internal consistency, then they would be appropriate for used in this study. Allen (2001) used the Cronbach’s alpha test for reliability, which yielded acceptable reliabilities for the different scales from 0.74 to 0.94.

The RMAS was an adaptation of one of the scales comprising the Fennema-Sherman Mathematics Attitude Scale, which was designed to measure “feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics” (Fennema & Sherman, 1976, p. 4), while the MAS measured participants’ deliberate attempts to avoid or escape from mathematical situations (Allen, 2001). Both the RMAS and MAS subscales comprised 10 Likert-type items, five of which were positively stated and five negatively stated. Each item utilized a 5-point Likert scale that uses the responses strongly disagree, disagree, undecided, agree and strongly agree. However, for this study the Likert-items were adapted to a 4-point Likert scale that used the responses strongly disagree, disagree, agree and strongly agree. The “undecided” response was omitted so that participants would be obligated to closely examine their thoughts before selecting their responses.

Positively worded items in the RMAS subscale were coded so that “1” corresponded to low mathematics anxiety and “4” to high mathematics anxiety. The reverse coding was applied for negatively worded items. The total possible score on the RMAS ranged from 10 to 40, with a higher score corresponding to a higher level of mathematics anxiety. The MAS subscale comprised five positively worded items and 5 negatively worded items. However, positively worded items were coded so that “1” corresponded to low tendency towards avoiding mathematics and “4” to high tendency towards avoiding mathematical situations. The total possible score on the MAS ranged from 10 to 40, with a higher score corresponding to a greater tendency towards demonstrating mathematics avoidance.

The PMTEB Subscale

Enochs, Smith, and Huinker (2000) developed the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) to assess pre-service teachers’ personal efficacy beliefs about teaching mathematics and their expectancy for their future teaching of mathematics developed. The

MTEBI consists of two subscales, the Personal Mathematics Teaching Efficacy Beliefs (PMTEB) and the Mathematics Teaching Outcome Expectancy (MTOE). Confirmatory factor analysis revealed that both subscales were independent of each other, and the Cronbach's alpha test for reliability yielded a high reliability of .88 for the PMTEB. However, for the purpose of this study only the PMTEB subscale was utilized because it proposed to assess the self-efficacy beliefs of practicing teachers at primary school, and not those of pre-service teachers who would hypothesize about what their future practice.

The PMTEB scale comprised 13 Likert-items, five positively stated and eight negatively stated. Each item utilized a 4-point Likert scale that uses the responses strongly disagree, disagree, neutral, agree and strongly agree. Items that are positively worded were coded so that "1" corresponds to low self-efficacy belief, and "4" to high self-efficacy belief. The reverse coding was applied to negatively worded items. The total possible score on the PMTEB scale ranged from 13 to 52, with a higher score indicating a higher level of self-efficacy for teaching mathematics.

Prior to administering the instrument to collect data for this study, the researcher administered it to five primary school teachers for consideration. They were asked to comment on the instrument with respect to its layout, its grammatical correctness and appropriateness of the language, its applicability to the constructs being measured, and its length. All errors or inconsistencies in these areas were immediately addressed and the instrument returned to these teachers for further comment. Once the researcher was satisfied that all issues were addressed, the instrument was reproduced and made ready to be administered.

Procedure for Data Collection

The researcher used the library at a tertiary level institution with which she was familiar to purposefully select participants from among primary school teachers who were enrolled in various programmes in Education. Thirty in-service primary school teachers who were at the library at the time, and who met the sample criteria previously identified, were asked to complete the questionnaire themselves. The nature and purpose of the study were explained to the participants. They were presented with an introductory letter and a consent form (see Appendix A). Once they all agreed, they were asked to immediately complete the questionnaire, which was subsequently collected and stored in a manila envelope.

The in-service teaches who completed the questionnaires were asked to take the questionnaires to their schools for their colleagues to complete. Fourteen participants agreed with the request. They were each given a manila envelope containing 5 copies of an introductory letter and five questionnaires. The volunteers were asked to seal the manila envelopes once they had collected the completed questionnaires from their colleagues and to return them to the researcher the following day. Volunteers returned to the researcher the sealed manila envelopes with three days of receiving them.

A total of 100 questionnaires were distributed, 72 were returned. This provided a response rate of 72%. Out of the 72, four were unusable and had to be discarded. Two respondents did not meet the criteria – one was a school principal and the other was taught at an early childhood center. Two respondents did not complete Section A adequately. One participant omitted their age and length of time teaching. Another participant omitted information about their age, length of time teaching, school type, and highest level of educational attainment. Records of how and when data were collected and organized were kept, and the data were labeled when collected.

Data Management and Analysis

Data derived from the questionnaire administered were managed and analyzed SPSS 18. First, background data captured by Section A of the questionnaire were compiled and organised in tabular form, representing a description of survey respondents by percentage of the total sample. This was followed by the calculation of descriptive statistics, including the mean and standard deviation, of participants' scores on each item on all subscales comprising the questionnaire (RMAS, MAS and PMTEB).

Pearson product-moment correlation coefficients were calculated to determine the degree of relationship between participants' total score on positively phrased items and negatively phrased items on the RMAS. This was repeated for similar items on the PMTEB and MAS. This was accompanied by an independent sample t-tests assuming equal variances to determine the if there was a significant difference between female and male teaches with respect to the positive and negatively phrased items on the RMAS, PMTEB and MAS.

Multiple univariate Analysis of Variance (ANOVA) were conducted to compare mean scores on the RMAS by highest level of achievement, number of years of teaching experience and age, to determine if there were differences among scores on these variables. Multiple comparisons were performed using the Tukey HSD procedure to determine where differences among groups occurred. These tests were repeated for mean scores on the PMTEB and MAS, by the same teacher variables as for the RMAS. The effect size was calculated for each comparison.

To identify the linear relationships between mathematics anxiety (as measured by the

RMAS), teacher efficacy (as measured by the PMTEB), and mathematics avoidance (as measured in the MAS) of primary school teachers, multiple correlations were conducted using Pearson's product-moment correlation at the 0.01 significance level. This was to calculate the direction and intensity of the relationships among the three constructs that were represented on the questionnaire. Consequently, a correlation matrix produced to identify relationships existing among these three constructs that were represented on the questionnaire.

Limitations of Study

The researcher acknowledges that the scale of this study is limited in terms of its reliability, since only a small percentage of the entire population of primary school teachers in Trinidad and Tobago was selected for the sample. It should be noted that the sample did not include participants from the Victoria and Tobago educational districts. The sample limits the study further due to the non-random sampling technique. The study was further limited by the disproportional representation of female and male teachers. A more gender-balanced sample may more accurately reflect teachers' perceptions, and improve the generalizability of the findings. However, consistent data collection techniques and rigorous data analysis techniques were employed to enhance validity and reliability of findings.

The researcher's interest in mathematics anxiety may have skewed data analysis in favour of finding responses to negatively phrased items. However, items comprising the questionnaire were derived from existing instruments that were tested for validity and thus supported the construct validity of the instruments used. Further, the data collected from participants were assumed an accurate depiction of their reality, and was analyzed with that in mind, protecting as far as possible the criterion validity of the subsequent findings. Content validity may be limited due to the small sample used.

The instrument used to collect data may further limit the scope of the study because of its composition. The three constructs under study may not be adequately measured because of the limited number of items related to each one. Other sub-constructs may have given a more complete understanding of them. These sub-constructs include test anxiety, numerical anxiety (Suinn & Winston, 2003)

This researcher was cognizant that participants' responses were subjective (seen through their eyes), and may not be accurate due to the time lapse between the occurrences of certain events and the instant participants was asked to recall these events. This may have compromise the researcher's assumption that participants' responses actually represented their beliefs and perceptions accurately. Participants who reported what they believe the researcher is expecting to hear, given the nature of the research, may have negatively impacted upon significant findings.

Chapter Summary

This chapter addressed the research methodology that was employed in this study, beginning with a restating of the problem being investigated, the purpose of the study, and the research questions. A detailed description of the sample and sample selection procedure was provided, which was followed by a detailed description of the self-reporting instrument that was designed and administered to participants. The chapter continued with the presentation of the data management and analysis techniques employed in the study, and concluded with the limitations of the study.

CHAPTER 4 – Report of Data and Data Analysis

Introduction

This chapter presents the findings of the analysis of primary school teachers' responses on the Mathematics Beliefs Questionnaire. The questionnaire comprised two sections. Section A collected personal and background data on the respondents. Section B collected respondents' perceptions about their mathematics anxiety, mathematics teacher efficacy and mathematics avoidance.

Data in both sections of the questionnaire were analyzed using SPSS 18 using various statistical procedures. First, descriptive statistics were used to analyze data captured in Section A of the questionnaire. Frequency of responses, means and standard deviations were calculated for each category. Respondents' profiles were identified by age, gender, highest level of educational achievement, educational district, government or government-assisted schools, schools' student composition by gender, and area of specialization in Teachers College Diploma.

Secondly, descriptive and inferential statistics were used to analyse data captured in Section B. For each subscale of Section B of the questionnaire, frequency distributions of the statements are presented. This is followed by correlational analyses of positively and negatively phrased items, to determine the relationship between pairs of variables. Group means were compared using independent sample t-tests and univariate analyses of variance to identify mean differences. Finally, relationships among teachers' perceptions of mathematics anxiety, mathematics teacher efficacy and mathematics avoidance, were analyzed and reported.

The Sample

This study involved 68 primary school teachers whose ages varied from 30 to 59 years, with 64.7% of them in the 30 – 39 years age group, 30.9% in the 40 – 49 group, and 4.4% in the 50 - 59 age group. Of the 68 participants 64.7% were female and the remaining 35.3% were male. Of the sample, 66.2% taught at government-assisted primary schools, while 29.4% taught at government schools. Of the sample, 76.5% taught at co-educational schools, while 13.3% taught either girls or boys at single-sex schools. There were 3 participants (4.4%) who did not indicate whether they taught at government or government-assisted schools, and a further 10.3% who did not indicate whether they taught at single-sex or co-educational schools. Each participant taught at one of the grade levels from Infants I to Post primary, with Standard 1 and standard 5 being the highest represented grade level (23.5% each) and post primary being the least represented (1.5%).

More than half of the participants (58.8%) were in-service primary school teachers who were enrolled in an undergraduate Bachelor of Education (B.Ed.), while 22.1% possessed a B.Ed. A further 63.2% possessed a Teachers Diploma, with 7.6% of these specializing in mathematics. Reportedly, 2.9% of participants had attained up to secondary school certification. One participant (1.5%) possessed a Masters in Education (M.Ed.); however, 14.7% indicated that they were pursuing an M.Ed. St. George East was the highest represented educational district (54.4%). South Eastern and St. Patrick districts were the lowest represented, each with 4.4% of respondents. Victoria and Tobago districts were not represented in the sample. A more comprehensive description of the survey respondents may be perused in Table 4.1.

Table 4.1

Profile of survey respondents (n = 68) percentage of respondents.

Profile	Frequency	% of study sample
Age group		
30 – 39	44	64.7
40 – 49	21	30.9
50 – 59	3	4.4
Gender		
Female	44	64.7
Male	24	35.3
Highest level of education		
Secondary school	2	2.9
Teachers Diploma	43	63.2
Bachelor in Education	15	22.1
Masters/Doctorate	1	1.5
Other	7	10.3
Educational district		
Caroni	14	20.6
North Eastern	5	8.8
Port of Spain	5	7.4
South Eastern	3	4.4
St. George East	37	54.4
St. Patrick	3	4.4
School type (i)		
Government	20	29.4
Government-assisted	45	66.2
School type (ii)		
Girls only	5	7.4
Boys only	4	5.9
Boys and girls	52	76.5
Teachers Diploma Specialization		
Mathematics	8	11.8
Other	58	85.3
Programme currently enrolled in		
Bachelor in Education	40	58.8
Masters/Doctorate	10	14.7

Mathematics Anxiety

Of the respondents, 58.8% agreed that they were at ease during mathematics courses, while 14.7% strongly disagreed with this statement. Similarly, 51.5% agreed that they were at ease during mathematics tests, and 26.5% disagreed with the statement. Similar proportions of respondents strongly disagreed (16.2%) and strongly agreed (17.6%) that they were never uptight while taking a mathematics test. There were almost equal proportions of respondents agreeing with (35.3%) and strongly agreeing (33.8%) that they were not bothered by taking more mathematics courses in the future. While 41.2% agreed and 20.6% strongly agreed that they were not worried about their problem-solving ability, 38.2% disagreed and 38.2% strongly disagreed that they felt a sinking feeling when trying to solve a difficult mathematics problem.

Of the respondents, while 11.8% and 13.2% respectively agreed that they felt uncomfortable and nervous about mathematics and uneasy and confused about mathematics, more than half of them (35.3% agreed and 33.8% strongly agreed) that they were not bothered about taking more mathematics courses.

Table 4.2 displays the percentage of respondents by item, as well as the mean score and standard deviation for each item.

Initial findings indicate an inverse relationship between the positively and negatively phrased items on the RMAS subscale. This suggests that more teachers had positive feelings about mathematics than negative feelings.

Table 4.2

Descriptive statistics: Mathematics anxiety (n = 68) percentage of respondents.

Perception	1	2	3	4	M	SD
Not bothered by taking more math courses.	11.8	17.6	35.3	33.8	2.88	1.06
At ease during math tests.	2.9	26.5	51.5	19.1	2.87	.75
At ease during math courses.	5.9	14.7	58.8	20.6	2.94	.77
Not worried about math problems-solving ability.	16.2	19.1	41.2	20.6	2.60	1.08
Never uptight while taking a math test.	16.2	27.9	38.2	17.6	2.57	.97
Uptight during math tests.	38.2	42.6	11.8	7.4	1.88	.89
Sinking feeling when trying a hard math problem.	38.2	38.2	16.2	7.4	1.93	.919
Blank mind, unclear thoughts when doing math.	52.9	38.2	4.4	4.4	1.60	.78
Uncomfortable and nervous about math.	48.5	33.8	11.8	5.9	1.75	.887
Uneasy and confused about math.	50.0	26.5	13.2	7.4	1.72	.99

1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree

* Table does not display non-responses to items.

Relationship between negatively and positively phrased items

An analysis using Pearson product-moment correlation coefficient indicated a significant linear relationship between respondents' total score on positively phrased items and negatively phrased items on the RMAS, $r(68) = -.708$, (2-tailed) $p < 0.01$. For these data, the strong inverse relationship between the scores on positively and negatively phrased items suggests that as respondents' positive feelings about mathematics increase, negative feelings about mathematics decrease.

Gender differences

An independent-samples t-Test assuming equal variances was conducted to determine whether there was a significant difference between male and female scores on the positively and negatively phrased items on the RMAS.

The analysis indicated that the mean score for female on positively phrased items (M = 13.33, SD = 3.29, N = 44) was significantly lower than the mean score for males (M = 15.46, SD = 2.87, N = 24), $t(66) = 3.073$, $p = .003$. A 95% confidence interval on the difference between the two means using an independent sample t distribution with 66 degrees of freedom is (.86, 4.06), which indicates that there is significant evidence that the means for females and males differ on positively phrased items. However, the mean score for females on the negatively phrased items (M = 9.50, SD = 3.68, N = 44) was significantly higher than the mean score for males (M = 7.75, SD = 2.45, N = 24), $t(66) = -2.083$, $p = .041$. A 95% confidence interval on the difference between the two means using an independent sample t distribution with 66 degrees of freedom is (-3.427, -.073). This difference, though significant, is negligibly so.

These findings suggest that female respondents reported higher levels of mathematics anxiety than male participants.

Other differences among the variables

The next set of analyses compared the mean scores of the positively and negatively phrased items on the RMAS by highest level of achievement, number of years of teaching, type of school (government or government-assisted schools) and current programme participants were enrolled in, to determine if there were differences among scores on these variables.

The ANOVA indicated no significant differences between mean scores on positively phrased items by highest level of achievement, F(4, 63) = 1.382, p = .269; type of school (government or government-assisted schools), F(4, 63) = 1.539, p = .202; number of years of teaching, F(20, 47) = 1.287, p = .234; and current programme participants are enrolled in F(2, 65) = .808, p = .45. Similarly, there was no indication of significant differences between mean scores on negatively phrased items by highest level of achievement, F(4, 63) = 1.183, p = .327; type of school (government or government-assisted schools), F(4, 63) = .725, p = .578; number of years of teaching, F(20, 47) = .765, p = .738; and current programme enrolled in F(2, 65) = .130, p = .878. Table 4.3 displays the results of these tests.

Table 4.3
ANOVA: Teachers' mathematics anxiety

Anxiety	Educational achievement		School type		Years teaching		Programme enrolled in	
	F	p	F	p	F	p	F	p
Positive	(4,63) = 1.328	.269	(4,63) = 1.539	.202	(20,47)=1.287	.234	(2,65) = .808	.450
Negative	(4,63) = 1.183	.327	(4,63) = .725	.578	(20,47) = .765	.738	(2,65) = .130	.878

$\alpha = 0.05$

These results suggest that there was no relationship between mathematics anxiety and teacher variables of highest level of educational achievement, school type, number of years teaching and current programme they were enrolled in.

Summary

The analysis of the relationship between positively and negatively phrased items on the RMAS revealed a strong inverse relationship. This meant that strong positive feelings about mathematics accompanied weak negative feelings about mathematics. However, it appeared that female teachers in the sample were reportedly more math-anxious than their male colleagues. On the other hand, mathematics anxiety did not appear to be related to teachers' highest level of educational achievement, type of school at which they taught, the number of years they have been teaching, and current programme they were enrolled in. In essence, however, the data suggests that mathematics anxiety was not evident among teachers in the sample.

Mathematics Teacher Efficacy

Of the respondents, 97.9% indicated that they continually find better ways to teach mathematics (58.8% agreed and 39.1% strongly agreed). Conversely, 10.3% indicated that they believed that they did not know how to turn students on to mathematics (7.4% agreed and 2.9% strongly agreed). Of the sample, 63.2% and 27.9% agreed and strongly agreed, respectively, that they understand mathematics concepts well enough to teach mathematics effectively.

With respect to actually teaching mathematics effectively, 76.5% and 8.8% agreed and strongly agreed, respectively, with the statement. On the other hand, 8.8% agreed that they did not understand mathematics concepts well enough to teach mathematics effectively, and 7.4% agreed that they actually do not believe that they teach mathematics as well as other subjects. Similarly, 7.4% indicated that they did not believe they had the necessary skills to teach mathematics.

Ninety-seven percent respondents indicated that they welcomed and could typically answer students' questions about mathematics (63.2% agreed and 27.9% strongly agreed). However, 16.2% indicated that they did not believe that they could help students who were experiencing difficulties in mathematics (8.8% agreed and 7.4% strongly agreed). Additionally, 10.3% agreed and 1.5% strongly agreed that it was difficult for them to use manipulatives to explain mathematics.

Of the sample, 10.3% and 2.9% agreed and strongly agreed, respectively, that they were ineffective at monitoring their students' mathematics activities. A small percentage of the sample (18.6%) of respondents indicated that they would not invite their principal to evaluate their teaching, while 18.6% would not.

Preliminary findings suggest an inverse relationship between the positively and negatively phrased items on the PMTEB subscale. In other words, as teachers' belief in their efficacy for teaching mathematics increased, their doubts about their efficacy decreased. Essentially, teachers had a high sense of self-efficacy, and they felt comfortable teaching mathematics. Table 4.4 displays the percentage of respondents, the mean score and standard deviation for each item.

Table 4.4
Descriptive statistics: Mathematics teaching efficacy (n = 68) percentage of respondents.

Perception	1	2	3	4	M	SD
Continually find better ways to teach math.	1.5	0	58.8	39.1	3.37	2.91
Can teach math concepts effectively.	2.9	11.8	76.5	8.8	2.91	.566
Understand concepts enough to effectively teach.	4.4	4.4	63.2	27.9	3.15	.697
Can typically answer students' questions.	0	2.9	63.2	33.8	3.31	.526
Usually welcome student questions.	0	2.9	54.4	42.6	3.40	.550
Cannot teach math as well as most other subjects.	54.4	33.8	7.4	2.9	1.56	.780
Ineffective in monitoring students' math activities.	36.8	48.5	10.3	2.9	1.84	.840
Generally teach mathematics ineffectively.	63.2	26.5	8.8	1.5	1.49	.723
Difficulty using manipulatives to explain math.	55.9	29.4	10.3	1.5	1.51	.782
Don't have necessary skills to teach math.	58.8	33.8	7.4	0	1.49	.635
Will not invite principal to evaluate teaching.	39.7	39.7	16.2	4.4	1.85	.851
Cannot help students with difficulty	55.9	27.9	8.8	7.4	1.68	.921
Do not know how to turn students on to math.	32.4	55.9	7.4	2.9	1.78	.730

1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree

* Table does not display non-responses to items.

Relationship between negatively and positively phrased items

An analysis using Pearson product-moment correlation coefficient indicated a significant linear relationship between respondents' total score on positively phrased items and negatively phrased items on the PMTEB, $r(68) = -.498$, (2-tailed) $p < 0.01$. These data indicate that positively phrased items were moderately inversely related to negatively phrased items on the PMTEB. In effect, this suggests that as teachers' self-efficacy increases, doubts about the efficacy for teaching mathematics decreases.

Gender differences

An independent-samples t-Test assuming equal variances was conducted to determine whether there was a significant difference between male and female scores on the positively and negatively phrased items on the PMTEB.

The analysis indicated that the mean score for males on positively phrased items ($M = 16.50$, $SD = 2.27$, $N = 24$) was not significantly higher than the mean score for females ($M = 15.93$, $SD = 2.10$, $N = 24$), $t(66) = 1.039$, $p = .303$. A 95% confidence interval on the difference between the two means using an independent sample t distribution with 66 degrees of freedom is (-.524, 1.661), which indicates not significant evidence that the means for females and males differed on positively phrased items.

The analysis indicated that the mean score for female on negatively phrased items ($M = 11.66$, $SD = 3.42$, $N = 44$) was not significantly higher than the mean score for males ($M = 10.96$, $SD = 3.54$, $N = 24$), $t(66) = -.798$, $p = .428$. A 95% confidence interval on the difference between the two means using a t-distribution with 66 degrees of freedom is (-2.455, 1.053). This indicates that there is no significant evidence that the means for females and males differ on negatively phrased items. Both female and male teachers have similar beliefs about their ability to teach mathematics effectively.

Other differences among the variables

The next set of analyses compared the mean scores of the positively and negatively phrased items on the PMTEB by highest level of achievement, number of years of teaching, type of school (government or government-assisted schools) and current programme participants were enrolled in, to determine if there were differences among scores on these variables. Table 4.5 displays the results of these tests.

Table 4.5

ANOVA: Mathematics teaching efficacy

Behaviour	Educational achievement		School type		Years teaching		Programme enrolled in	
	F	*p*	F	*p*	F	*p*	F	*p*
Positive	(3,64) = 1.711	.174	(4,63) = 1.675	.167	(20,47)=1.826	.046	(2,65) = 0383	.683
Negative	(3,64) = 1.060	.373	(4,63) = .601	.663	(20,47) = .502	.952	(2,65) = .354	.703

α = 0.05

The results of the ANOVA indicated that there were no significant differences between mean scores by positively phrased items on highest level of achievement, F(3, 64) = 1.382, p = .269; type of school (government or government-assisted schools), F(4, 63) = 1.539, p = .202; and current programme participants are enrolled in F(2, 65) = .808, p = .45. However, there was a significant difference on positively phrased items on number of years of teaching, F(20, 47) = 1.826, p = .046. A post hoc test was not performed to determine between which groups the difference(s) occurred. This is because there were one or more groups with less than two respondents. However, although the difference was significant ($p = .045$), it only minutely differed from .05, therefore it was only negligibly significant.

The results also indicated that there were no significant differences between mean scores on negatively phrased items by highest level of achievement, $F(3, 64) = 1.060$, $p = .373$; type of school (government or government-assisted schools), $F(4, 63) = .601$, $p = .663$; number of years of teaching, $F(20, 47) = .502$, $p = .952$; and current programme participants are enrolled in $F(2, 65) = .354$, $p = .703$.

In essence, teacher efficacy was not related to teachers' highest level of educational achievement, type of school at which they taught, the number of years they have been teaching, and current programme they were enrolled in

Summary

Preliminary findings from participants' responses on the PMTEB subscale suggest that teachers believed that they taught mathematics effectively, and they were comfortable teaching mathematics. Pearson's product moment correlation coefficient revealed that as teachers' sense of mathematics teacher efficacy increased, there was a decrease in their doubt about their self-efficacy. An independent samples t-test indicated that both female and male teachers held similar beliefs about efficacy for teaching mathematics. A series of analysis of variance tests suggested that mathematics teacher efficacy was not related to teachers' highest level of educational achievement, type of school at which they taught, the number of years they have been teaching, and current programme they were enrolled in. In essence, teachers have a high sense of self-efficacy for teaching mathematics. An initial analysis of the data so far also suggests that there is a stronger relationship between positively and negatively phrased items with regards to mathematics anxiety than for mathematics teacher efficacy.

Mathematics Avoidance

Of the sample, 51.5% agreed and 41.2% strongly agreed that they looked forward to teaching mathematics. Conversely, 4.4% and 2.9% of respondents agreed and strongly agreed, respectively, that they did not want to teach mathematics in the future. More than half of the sample (64.7%) did not take elect to participate in mathematics competitions.

Of the responses to assisting others with their mathematics homework, 25% strongly disagreed and 39.7% disagreed with the statement, indicating that they did not assist others with their mathematics homework. A total percentage (72.1%) of respondents reported that they did not select mathematics as their area of emphasis. Conversely, a total of 22.1% of respondents reported that they chose an area of study that did not require mathematics.

Approximately 27% and 46% of respondents strongly disagreed and disagreed, respectively, that they take mathematics classes that they were not required to take. Conversely, about 3% reported that they did not take mathematics in the last year of secondary school. Also, 7.4% reported that they dropped mathematics courses because they experienced difficulty with them. Finally, a large percentage of respondents disagreed with avoiding taking mathematics classes after leaving secondary school.

Table 4.6 displays the percentage of respondents by item, as well as the mean score and standard deviation for each item. The first five items in Table 4.6 are positively phrased, and the remaining five are negatively phrased.

Table 4.6
Descriptive statistics: Mathematics avoidance behaviours (n = 68) percentage of respondents.

Behaviours	1	2	3	4	M	SD
Looked forward to teaching math.	1.5	4.4	51.5	41.2	3.29	.75
Elected to take part in math competitions.	25	39.7	27.9	7.4	2.18	.90
Selected math as my area of emphasis.	30.9	41.2	14.7	11.8	2.12	1.03
Helped others with their math homework.	5.9	13.2	57.4	23.5	2.99	.78
Taken math classes that were not required.	26.5	45.6	17.6	5.9	1.94	.93
Did not want to teach math in the future.	67.6	23.5	4.4	2.9	1.40	.73
Did not take math in last year of secondary school.	76.5	20.6	1.5	1.5	1.28	.57
Avoided taking math classes after school.	36.8	44.1	13.2	4.4	1.82	.85
Chose area of study not requiring math courses.	39.7	36.8	16.2	5.9	1.85	.92
Dropped math courses because of difficulty.	61.8	30.9	5.9	1.5	1.47	.46

1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree

* Table does not display non-responses to items.

This initial analysis of the data suggests and an inverse relationship between the positively and negatively phrased items on the MAS subscale. That means that teachers were less prone to avoid mathematics than they were to not avoid it.

Relationship between negatively and positively phrased items

Using Pearson product-moment correlation coefficient to investigate the relationship between positively and negatively phrased items on the MAS indicated a moderately significant inverse relationship between the two categories of responses, $r(68) = -.483$, (2-tailed) $p < 0.01$. For these data, the moderately inverse relationship suggests that as teachers' felt more comfortable with mathematics, they reported less avoidance of mathematics.

Gender differences

An independent-samples Student's t-Test assuming equal variances was conducted to determine whether there was a significant difference between male and female scores on the positively and negatively phrased items on the MAS.

The analysis indicated that the mean score for female on positively phrased items (M = 11.84, SD = 2.82, N = 44) was significantly lower than the mean score for males (M = 13.75, SD = 2.71, N = 24), t(66) = 2.705, p = .009 . A 95% confidence interval on the difference between the two means using an independent sample t distribution with 66 degrees of freedom is (.500, 3.318), which provided significant evidence that the means for females and males differ on positively phrased items. This means that males reported a lower tendency to avoid mathematics than females.

On the other hand, the mean score for female on negatively phrased items (M = 7.86, SD = 2.57, N = 44) was not significantly higher than the mean score for males (M = 7.75, SD = 2.07, N = 24), t(66) = -.186, p = .853. A 95% confidence interval on the difference between the two means using an independent sample t distribution with 66 degrees of freedom is (-1.332, 1.104). These findings suggest that female respondents reported approximately the same levels of mathematics avoidance as male participants.

Other differences among the variables

These analyses compared the mean scores of the positively and negatively phrased items on the MAS by highest level of educational achievement, number of years of teaching, type of school (government or government-assisted schools) and current programme participants were enrolled in, to determine if there were differences among scores on these variables. Table 4.7 displays the results of these tests.

Table 4.7

ANOVA: teachers' mathematics avoidance

Behaviour	Educational achievement		School type		Years teaching		Programme enrolled in	
	F	p	F	p	F	p	F	p
Positive	(4,63) = 1.290	.283	(4,63) = .498	.737	(20,47)=1.191	.303	(2,65) = 2.127	.127
Negative	(4,63) = 3.366	.015	(4,63) = .191	.942	(20,47) = .994	.486	(2,65) = .475	.624

α = 0.05

The results of the ANOVA indicated no significant differences between mean scores on positively phrased items by highest level of educational achievement, F(4, 63) = 1.290, p = .283; type of school (government or government-assisted schools), F(4, 63) = 1.191, p = .737; number of years of teaching, F(20, 47) = 1.191, p = .303; and current programme participants are enrolled in F(2, 65) = 2.127, p = .127.

There were also no significant differences between mean scores on negatively phrased items by type of school (government or government-assisted schools), F(4, 63) = .191, p = .942; number of years of teaching, F(20, 47) = .994, p = .486; and current programme participants are enrolled in F(2, 65) = .475, p = .624. However, there was a significant difference between mean scores on negatively phrased items by highest level of educational achievement, F(4, 63) = 3.366, p = .015. A post hoc test was not performed to determine where the difference(s) occurred since there was one group with only two respondents. However, a comparison of the means of responses to negatively phrased items by highest level of educational achievement was conducted. Table 4.8 displays the results.

Table 4.8

Descriptive statistics for mathematics avoidance (negative)

Highest level of educational achievement	N	Mean	Standard Deviation
Secondary school	2	12.50	7.78
Teachers Diploma	43	7.53	2.05
B.Ed.	15	8.52	2.07
Other	8	7.82	2.39

An analysis of the means by highest level of educational achievement reveals similar means and standard deviations for respondents with a Teachers Diploma (N = 43, M = 7.53, SD = 2.051), a B.Ed. (N = 15, M = 8.53, SD = 2.066), and other certification (N = 8, M = 7.82, SD = 2.387). On the other hand, the mean and standard deviation for respondents with only secondary school certification are much higher than the other categories (N = 2, M = 12.50, SD = 7.78). A high mean score on negatively phrased mathematics avoidance items indicates a high tendency to avoid mathematics.

Further, the mean difference between the secondary school group and the other groups is approximately five points. On the contrary, the mean difference between any other pairs of groups is less than one point. These results suggest that there was significant difference in mathematics avoidance between teachers with only secondary school certification and those with higher levels of educational achievement. Thus, teachers with only secondary school certification tend to avoid mathematics more than those with higher certification.

On the other hand, although there was no significant difference between mean scores on positively phrased items by highest level of educational achievement, a post hoc Tukey HSD revealed interesting results. There was a mean difference of less than one point between respondents pursuing a B.Ed. and those who did not indicate. Those pursuing a B.Ed. scored higher. This finding may not be significant since the educational status is not known for those who did not respond to this item.

However, there was a mean difference of more than two points between respondents who were pursuing a M.Ed. and those who were pursuing a B.Ed. Those pursuing a M.Ed. scored higher than those pursuing a B.Ed. A higher score on the positively phrased items on the MAS indicates a lower tendency to avoid mathematics. Table 4.9 displays these results.

Table 4.9

Post Hoc Tukey HSD test for multiple comparisons of means

Dependent variable	Programme level (I)	Programme level (J)	Mean difference (I – J)	Significance
Math avoidance	None indicated	B. Ed.	-.587	.752
positive	None indicated	M.Ed.	-1.489	.309
	B.Ed.	M.Ed.	-2.075	.108

$\alpha = 0.05$

These results suggest that teachers pursuing a M.Ed. reportedly avoided mathematics less than those pursuing a B.Ed. Thus, respondents pursuing higher degrees reported a lower tendency to avoid mathematics.

Summary

Preliminary data analysis of participants' responses revealed that teachers who held positive feelings about mathematics were less likely to avoid it. The independent sample t-test indicated that male teachers held less unfavourable feelings towards mathematics than females, but both male and female teachers reported similar tendencies to avoid mathematics. An analysis of variance of mean scores on positively and negatively phrased items indicated no significant relationship between mathematic avoidance and the type of school at which they taught, the number of years they have been teaching, and current programme they were enrolled in. However, it was observed that teachers pursuing higher degrees reported lower tendencies to avoid mathematics. There was however, a significant relationship between mathematics avoidance and teachers' highest level of educational achievement, with teachers with only secondary school certification reporting the highest levels of mathematics avoidance.

Mathematics Anxiety, Mathematics Teacher Efficacy, and Mathematics Avoidance

Pearson's product moment correlation coefficients were calculated to describe the pair-wise relationship between mathematics anxiety, mathematics teacher efficacy and mathematics avoidance. Tests were conducted at the significance level of 0.01 (2-tailed). The correlation matrix in Table 4.10 displays the results.

Table 4.10

Correlation matrix: Mathematics anxiety, mathematics teacher efficacy, and mathematics avoidance.

	MAn (+)	MAn (-)	MTE (+)	MTE(-)	MAv (+)	MAv (-)
MAn (+) (significance)	1	-.708 .000	.575 .000	-.392 .001	.550 .000	-.453 .000
MAn (-) (significance)	-.708 .000	1	-.548 .000	.564 .000	-.624 000	.618 .000
MTE (+) (significance)	.575 .000	-.548 .000	1	-.498 .000	.477 .000	-.517 .000
MTE(-) (significance)	-.392 .001	.564 .000	-.498 .000	1	-.515 .000	.608 .000
MAv (+) (significance)	.550 .000	-.624 000	.477 .000	-.515 .000	1	-.483 .000
MAv (-) (significance)	-.453 .000	.618 .000	-.517 .000	.608 .000	-.483 .000	1

* Correlation is significant at the 0.01 level (2-tailed)

Key for Table 4.9:

MAn (+) – mathematics anxiety positively phrased items
MAn (-) – mathematics anxiety negatively phrased items
MTE (+) – mathematics teacher efficacy positively phrased items
MTE (-) – mathematics teacher efficacy negatively phrased items
MAv (+) – mathematics avoidance positively phrased items
MAv (-) – mathematics anxiety negatively phrased items

The analysis of the correlation matrix indicates that there were some strong and moderate significant pair-wise relationships observed between the three constructs under investigation in this study.

Mathematics Anxiety and Mathematics Teacher Efficacy

There was a strong positive relationship observed between negatively phrased mathematics anxiety items and negatively phrased mathematics teacher efficacy items ($r = .608$, $p < 0.01$).

Respondents who agreed with negatively phrased mathematics anxiety items also agreed with negatively phrased mathematics teacher efficacy items. This was corroborated by the moderate inverse relationship between negatively phrased mathematics anxiety items and positively phrased mathematics teacher efficacy items ($r = -.548$, $p < 0.01$). Further support was provided by the moderate positive relationship between negatively phrased mathematics anxiety items and negatively phrased mathematics teacher efficacy items ($r = .564$, $p < 0.01$). Moreover, the moderate positive relationship between positively phrased mathematics anxiety items and positively phrased mathematics teacher efficacy items ($r = .575$, $p < 0.01$) supported these findings. These results suggest that as teachers negative feelings about mathematics strengthened, they felt less confident about their ability to teach mathematics effectively. Conversely, as teachers' feelings about mathematics became more positive, they felt more confident in their ability to teach mathematics effectively.

Mathematics Anxiety and Mathematics Avoidance

A strong relationship emerged between the negatively phrased mathematics anxiety items and the positively phrased mathematics avoidance items ($r = -.624$, $p < 0.01$). Respondents who reported higher levels of mathematics anxiety tended to avoid mathematics. The next strong relationship occurred between negatively phrased mathematics anxiety items and negatively phrased mathematics avoidance items ($r = .618$, $p < 0.01$). This indicated that respondent who agreed with the negatively phrased mathematics anxiety items also agreed with the negatively phrased mathematics avoidance items. Essentially, as teachers' mathematics teaching anxiety increases, they were more likely to avoid mathematics. Conversely, as teachers' mathematics anxiety decreases, they were less likely to avoid mathematics.

Mathematics Teacher Efficacy and Mathematics Avoidance

Moderate relationships were also observed between mathematics teacher efficacy and mathematics avoidance. The moderate inverse relationship observed between positively phrased mathematics teacher efficacy items and negatively phrased mathematics avoidance items ($r = -.517$, $p < 0.01$), indicated that respondents who agreed with positively phrased mathematics teacher efficacy items disagreed with negatively phrased mathematics avoidance items. A similar relationship was evident between negatively phrased mathematics teacher efficacy items and positively phrased mathematics avoidance items ($r = -.515$, $p < 0.01$), indicated that respondents who agreed with negatively phrased mathematics teacher efficacy items disagreed with positively phrased mathematics avoidance items. Hence, as teachers became more confident about teaching mathematics, they were less likely to avoid mathematics. However, as teachers became less confident about teaching mathematics, they were more likely to avoid mathematics.

Summary

The findings from the correlational analyses of mathematics anxiety, mathematics teacher efficacy and mathematics avoidance indicated that there were significant relationships between them. While such analyses could not determine a cause-effect relationship between these constructs, they were able to determine the direction and strength of these relationships. Analysis suggested that mathematics anxiety was strongly related to both mathematics teacher efficacy and mathematics avoidance.

In essence, the findings suggest that teachers who reported high mathematics anxiety also reported low self-efficacy beliefs about their ability to teach mathematics, and were more likely to avoid mathematics. Further, teachers who had a high sense of self-efficacy for teaching mathematics were less likely to avoid mathematics. The converse is also true for both inferences from the data.

Summary of the Findings

This chapter presented the findings of the data analysis. Analysis of the data involved calculating both descriptive and inferential statistics to identify significant relationships between constructs, and the direction and strength of these relationships. This analysis involved the use of frequency distributions, means, standard deviations, correlational analyses, means difference tests, and analyses of variance. Findings were reported for each of the three constructs explored in the study. The findings suggest the following:

- Respondents generally did not report that they were math-anxious. However, female teachers in the sample appeared more math-anxious than male teachers. There appeared to be no significant relationship between mathematics anxiety and teachers' highest level of educational achievement, type of school at which they taught, the number of years they have been teaching, and current programme they were enrolled in.
- Both female and male teachers equally reported that they taught mathematics effectively and that they were comfortable teaching mathematics. Further, as confidence about their ability to effectively teach mathematics increased, their doubts about their self-efficacy decreased. There appeared to be no significant relationship between mathematics teacher

efficacy and teachers' highest level of educational achievement, type of school at which they taught, the number of years they have been teaching, and current programme they were enrolled in. However, as teachers became more math-anxious, they became less confident about their ability to teach mathematics effectively.

- While female teachers appeared to hold more negative feelings about mathematics, both female and male teachers reported similar tendencies to avoid mathematics. However, respondents who reported positive feelings about mathematics were less likely to avoid it. There was no significant relationship between mathematic avoidance and the type of school at which they taught, and the number of years they have been teaching. Although there was not significant relationship observed by current programme teachers were enrolled in, those teachers pursuing higher education were less prone to avoid mathematics. There was a significant difference in mathematics avoidance with respect to teachers' highest level of educational achievement.

CHAPTER 5 - Discussion, Conclusions, and Implications

Introduction

This chapter discusses the findings reported in Chapter 4, with respect to the research questions presented in Chapter 1. The chapter begins with an overview of the study. This is followed by a discussion of the findings from which conclusions will be drawn. Subsequently, the implications of the study will discussed, and suggestions offered for further research about mathematics anxiety in primary school teachers in Trinidad and Tobago.

Discussion of Findings

Research question 1a: Is there a difference in mathematics anxiety and teacher variables of gender, age, highest level of education, and number of years of teaching experience?

Teachers in this study were not generally math-anxious. However, that mathematics anxiety exists among them is unquestionable. Rather, the extent to which it is the bigger question. As much as one quarter of respondents reported feeling uncomfortable, nervous, uneasy and confused about mathematics. Even fewer reported experiencing dis-ease during mathematics courses. This dis-ease though, was not confined to learning mathematics. Some reported experiencing some anxiety during mathematics examinations, supporting the findings of Smith (1997) and Swars et al. (2006). While this study did not investigate the reasons for this occurrence, research suggest that anxiety interferes with how individuals learn and do mathematics (Tobias, 1993).

Some respondents reported concerns about their problem-solving ability, and experiencing anxiety when trying to solve a difficult mathematics problem. Cohen and Green (2002) suggest that anxiety about solving mathematics problems are a consequence of poor conceptual understanding of mathematical. This may be traced to these teachers' personal experiences with learning mathematics in the historically teacher-centered classrooms in Trinidad and Tobago, in which the focus was on developing procedural over conceptual understanding of mathematics. The question of how mathematics is taught in the primary school classroom begs further study.

Interestingly, female teachers in this study reported marginally higher levels of mathematics anxiety than males. However, there is no consensus among educators to substantiate this finding. While Tobias & Weissbrod (1980) support this finding, Shields (2005) disputes it. Unfortunately, gender stereotypes about mathematics do exist in Trinidad and Tobago, though not as prevalent as before. Nonetheless, the teachers in this study would have been exposed to these stereotypes as students. These stereotypes are still believed because, as McLeod (1993) suggests, attitudes about mathematics are formed quite early in life, and persist into adulthood. Teachers need to become aware of their own perceptions about gender and desist from propagating this stereotype (Smith & Smith, 2007; Shields, 2005; Johnson, 2003).

Research question 1b: Is there a difference in mathematics teacher efficacy and teacher variables of gender, age, highest level of education, and number of years of teaching experience?

Both female and male teachers in this study equally reported a high sense of self-efficacy for teaching mathematics, and a high level of comfort teaching mathematics. Although this finding corroborates those of Hoy and Woolfolk, (1993), Cheung (2006) found that female teachers have higher efficacy beliefs than their male colleagues. Almost all respondents reported that they continually find better ways to teach mathematics, corroborating the research findings of Riggs and Enochs (1990) and Allinder (1995). However, few teachers in the sample reportedly did not believe that they possess the necessary skills to teach mathematics effectively, nor could they teach maths as well as they taught other subjects. These findings mirror those of Wright and Miller (1981).

Few respondents reportedly did not understand mathematics concepts well enough to teach mathematics effectively. Hembree (1990) suggests that this loss of mathematical power gives way to mathematics anxiety. Further, Peker (2009) attributed such negative attitudes about self-efficacy to teachers' self-confidence and their content and pedagogical knowledge. Godbey (1997) cautions that as teachers' self-confidence to teach mathematics decline, so to does their mathematics teacher efficacy. These finding are consistent with sentiments teachers shared with the researcher prior to this study.

All but one respondent reportedly welcomed and answered students' questions about mathematics. This finding is consistent with that of Gibson and Dembo, (1984), which suggests that efficacious teachers experience low levels of mathematics anxiety. Although some respondents reportedly did not believe that they could help students who were experiencing difficulties in mathematics, they were not given the opportunity to elaborate. This question is worth investigation in another study. However, this may be because teachers do not understand how mathematics is learned, so they cannot help students with their difficulties (Kennedy, 1998), especially in the absence of professional training that exposes them to the psychology of teaching and learning mathematics.

This study did not find any relationship between teachers' highest level of achievement, type of school at which they taught, and current programme they were enrolled in. However, mathematics teacher efficacy appeared to be marginally related to the number of years of teaching experience. Wenner (2001) reported that teaching experience increases teacher efficacy. Wenner's point may have some merit since the majority of the teachers in this study (90%) had been teaching for more than 10 years. Additionally, almost all of them (97%) possessed a Teachers Diploma.

Research question 1c: Is there a difference in mathematics avoidance and teacher variables of gender, age, highest level of education, and number of years of teaching experience?

Teachers in this study generally reported positive feelings about mathematics and little mathematics avoidance behaviours. Yet, they did not engage in mathematics outside of their classroom when they were students. They generally did not help others with their mathematics homework, nor did they participate in mathematics competitions. However, this may not be a result of mathematics avoidance, but as a result of limited opportunities to have done so in their past.

While many teachers reportedly looked forward to teaching mathematics, a small percentage did not want to teach mathematics in the future. Although they were not able to elaborate on their response, Trice and Ogden (1986) suggest that math-anxious teachers avoid teaching mathematics whenever possible. It is not clear whether these few individuals were math-anxious, but it is likely that they may have been.

More teachers did not pursue studies in mathematics after secondary school than those who did. This finding mirrors those of other studies by Hembree (1990), Ma (1999), Nicalaou and Phillipou (2007), and Seaman (1999). Kelly and Tomhave (1985) Further, individuals become primary school teachers because they of the job. However, it cannot be inferred from this study that individuals become primary school teachers because they perceive that the profession requires less mathematics than other professions, as was suggested by Kelly and Tomhave (1985) about elementary teachers. Additionally, teachers in this study generally reported low mathematics avoidance, so it would be unreasonable to infer that this was their reason for becoming teachers. However, this question warrants further research.

Interestingly, mathematics avoidance was not linked to gender in this study, contradicting findings of Kelly and Tomhave (1985); however, female teachers reported more feelings that are unfavourable about mathematics than males. Further, mathematics avoidance was not related to the type of school at which respondents taught, the number of years they have been teaching, or current programme they were enrolled in. Yet, teachers with only secondary school certification reported higher levels of mathematics avoidance than those with higher certification. Teachers pursuing graduate studies in Education reportedly avoided mathematics less than those pursuing undergraduate studies.

Research question 2: Is there a relationship between mathematics anxiety, beliefs about efficacy in teaching mathematics, and teachers' mathematics avoidance?

The purpose of this study was not to determine cause-effect relationships between the constructs under study; rather, the direction and strength of relationships between constructs that were observed. It was found that for the teachers who participated in this study, low levels of mathematics anxiety were associated with high mathematics teacher efficacy and low levels of mathematics avoidance. On the other hand, for these same teachers, high levels of mathematics teacher efficacy accompanied low levels of mathematics avoidance. These findings are consistent with the literature on mathematics anxiety and its relationship with these two constructs. They are also consistent with the researcher's observations from informal conversations and interactions with primary school teachers.

Implications for Education in Trinidad and Tobago

The findings of this study have clear implications for mathematics education in primary schools. Firstly, this study explored the perceptions about mathematics anxiety, mathematics teacher efficacy and mathematics avoidance of practicing teachers in Trinidad and Tobago. This is in contrast to much of the existing literature, which addressed mathematic anxiety in pre-service elementary teachers. Exploring mathematics anxiety among this group of teachers not only adds to the literature on mathematics anxiety; it also attempts to highlight the paucity of research in this area in Trinidad and Tobago, and it mathematics education overall.

This study also brought these constructs to the fore for those teachers who participated in the study, permitting them, even briefly, to reflect on their practice and their perceptions. This kind of reflection allows teachers to critically examine themselves and their practice. They become acutely aware of how their own background and experiences have shaped their perspectives on education. Moreover, they can become cognizant of how their demonstrated attitudes, beliefs, and dispositions towards mathematics influence the teaching and learning environment they create.

Helping teachers understand the construct of mathematics anxiety and how it bears upon the teaching and learning of mathematics empowers them to help their students with their own anxieties. This also helps break the cycle of mathematics anxiety and mathematics avoidance. As students observe their teachers demonstrate positive attitudes about mathematics, and confidence in their ability to do and teach mathematics, students learn these behaviours and themselves become empowered to do and learn mathematics.

This study also brings to the fore the relationship between mathematics anxiety, mathematics teacher efficacy and mathematics avoidance. Mathematics anxiety is often believe to be the precursor to teacher efficacy and mathematics avoidance. The findings of this study supports the current literature that says that highly math-anxious teachers tend to be less efficacious mathematics teachers and tend to avoid mathematics more than those have low mathematics anxiety. This raises concerns about what is happening in the primary classroom.

Math-anxious teachers transmit their anxieties and attitudes about mathematics to their students, which research suggests retards students mathematical development. It is imperative that teacher educators and teacher education programmes address mathematics anxiety in primary school teachers, in addition to mathematics content and pedagogy specific to mathematics instruction. This particular group of individuals is all required to teach mathematics, regardless of their competence, effectiveness, or desire to avoid it. Therefore, equipping them with the tools to manage their anxieties may reduce its long-term effects in the classroom by producing efficacious and confident teachers who create a classroom culture that is positive, collaborative, creative, transformative, and supportive of student learning and achievement in mathematics.

Recommendations for Future Research

This exploratory study examined the perceptions of primary school teachers about their mathematics anxiety, mathematics teacher efficacy and mathematics avoidance. While the findings suggest that the participants were generally not math-anxious, the researcher is aware that this sample represents only some of the primary school teachers in Trinidad and Tobago.

Thus, a true reflection of teachers' perceptions and their reality may not have been revealed at this time, but are worthy of further exploration.

The findings of this exploratory study may not be generalizable to the entire population of primary school teachers in Trinidad and Tobago for several reasons. These include the size of the sample, the use of non-random sampling techniques, the under-representation of all educational districts, the limited number of teacher demographics investigated, and the limited insight that a purely quantitative study can provide. Thus, this study ought to take the form of a mixed-method design that utilizes both quantitative and qualitative techniques to investigate the phenomenon of mathematics anxiety in the local context. A study of that nature ought to be wide enough in scope to address all the issues previously outlined that limit the generalizability of the findings of this study. However, this study was useful in raising questions that require further investigation about the teaching and learning environment in primary schools.

This study has raised some pertinent concerns about mathematics education in Trinidad and Tobago that ought to be investigated. One such concern is related to the pervasiveness of mathematics anxiety among primary school teachers in Trinidad and Tobago. There is no data that indicates the extent to which primary school teachers are math-anxious. Further, primary school teachers have not been encouraged to reflect on their own mathematics anxiety. A study that focuses on this would not only help teachers identify themselves as math-anxious; it could direct them to appropriate strategies to manage it.

The gap in the literature about mathematics anxiety in the local context, which differs from societies that train teachers prior to their entry into the classroom, has serious implications for the way that mathematics is taught in primary schools. The literature links students' mathematics anxiety to the teaching and teachers of mathematics. It suggests that mathematics anxiety is perpetuated by classroom teachers, particularly those at the elementary or primary level.

Further research ought to be conducted to determine the causes of mathematics anxiety among primary school teachers, with particular reference to their early experiences with mathematics in the classroom. Of interest too, is to determine if these experiences have impacted females and males differently. Research about mathematics anxiety should also include the perspective of students to provide a more complete picture of what is happening with mathematics instruction in the classroom. Thus, the paucity of empirical data about how mathematics anxiety influences the teaching and learning of mathematics in the primary classroom in Trinidad and Tobago warrants further study.

The limited research about mathematics education has also limited the collection of evidence about mathematics teacher efficacy of primary school teachers, a construct that has been linked to mathematics anxiety. Teacher efficacy is a critical component of the teaching and learning environment, and with growing concerns about falling student achievement in mathematics and its link to the teaching of mathematics, research in this area is imperative. Research about teacher efficacy would inform educators about teachers' perceptions about efficacy for teaching mathematics, and reveal what teachers perceive that they need to become more efficacious. This data could inform teacher preparation and training, so that teacher efficacy, as well as mathematics anxiety and avoidance, could be adequately addressed. This would facilitate the development of highly efficacious primary school teachers.

Further study of mathematics anxiety could involve an analysis of the training needs of teachers. This data could be used to develop appropriate courses which focus on content, methods, pedagogy and the psychology of how mathematics is learned. These courses ought to facilitate teachers' recognizing their attitudes, beliefs and misconceptions about mathematics and mathematics instruction. They should provide teachers with information about the relationship between anxiety and student performance. They should provide teachers with strategies to manage their anxiety so that it does not hamper their efficacy and enjoyment of their vocation. This will prepare teachers to teach mathematics effectively, and enhance the learning experiences they provide their students.

Conclusion

This study was inspired by comments made by primary school teachers with whom the researcher interacted with during the course of teaching them a course on appreciating mathematics. It was not the researcher's intention to identify cause-effect relationships. The researcher's intention was to explore and clarify the relationships between mathematics anxiety, mathematics teacher efficacy and mathematics avoidance among the primary school teacher population in Trinidad and Tobago. This exploratory study accomplished its purpose, albeit on a small scale.

The study revealed that for sample used, mathematics anxiety and mathematics avoidance was low, while mathematics teacher efficacy was high. This means that generally, these teachers were not math-anxious, and believed that they were effectively teaching mathematics. They also reported that they tended not to avoid mathematics or mathematics-related situations. Further, there was no evidence to suggest that these constructs were significantly related to teachers' gender, the type of school at which they taught, the number of years they had been teaching, and current programme they were enrolled in. However, there was some relationship between mathematics avoidance and teachers' highest level of educational achievement.

It is suggested in the literature on mathematics anxiety and mathematics teacher efficacy that these constructs are related to early experiences with school mathematics and mathematics teachers. However, significant research has been undertaken involving pre-service teachers, leaving a gap in the data about currently practicing teachers. This gap is further widened due to the dearth of research in the Caribbean and local context. In some way, this study was intended to narrow this gap.

This study also causes one to pause and ponder the realities of the teaching and learning environment, particularly at the primary level. Several issues should raise concerns. There ought to be concerns about untrained teachers teaching mathematics when there is no guarantee that their mathematical content knowledge is adequate and sound. Concerns about teachers' pedagogical practices and competencies for teaching mathematics, with or without prior training ought to be at the forefront. This in light of the relationship that research has unearthed about the impact of teachers' classroom practices on student learning and achievement in mathematics.

Additional concerns relate to the affective aspect of teaching, for both teachers and students. Research points to mathematics anxiety being a construct that develops as a result of repeated onslaught of negative experiences with mathematics, particularly within the classroom environment. Research also places teachers at the center of these experiences, and hold them responsible for perpetuating negative attitudes towards mathematics, and the development of mathematics anxiety in their students. Eventually, some of these math-anxious students become teachers, who perpetuate negative attitudes towards mathematics.

It is imperative that as educators, we address all the domains of learning, including the affective, where mathematics anxiety lies. In this way, we are assured that teachers who enter the classroom are prepared with content knowledge, pedagogical knowledge, and appropriate attitudes and dispositions for teaching mathematics. The impact on the teaching and learning environment will extend beyond the classroom, as students acquire the knowledge, skills and attitudes that make them successful outside the classroom.

References

Allen, D. S. (2001). Mathematics experience: contributing factors to the math anxiety and avoidance behaviours of female elementary school pre-service teaches. Unpublished doctoral dissertation, Texas Tech University, Texas

Allinder, R. (1995). An examination of the relationship between teacher efficacy and curriculum-based measurement and student achievement. Remedial and Special Education, 16(4), 247-254.

Alsup, J. K. (2003). New classroom rules to promote preservice elementary teachers' mathematics leaning. Education, 123(3), 609-614.

Angen, M. J. (2000). Evaluating interpretive inquiry: Reviewing the validity debate and opening the dialogue. Qualitative Health Research. 10(3) pp. 378-395.

Ashcraft, Mark H. (2002). Math Anxiety: Personal, Educational, and Cognitive Consequences. Current Directions in Psychological Science, 11(5), 181-185.

Ashcraft, M. H., & Faust, M. W. (1994). Mathematics anxiety and mental arithmetic performance: An exploratory investigation. *Cognition and Emotion*, 8, 97-125.

Ashcraft, M. H., Krause, J. A., & Hopko, D. R. (2007). Math Anxiety as a Mathematics Learning Disability. In D. B. Berch & M. M. M. Mazzocco (Eds.), Mathematical Learning Disabilities: Research, Theory, and Practice (pp. 329-348). New York: Plenum.

Ashton, P.T., & Webb, R. B., (1986). Making a difference: Teachers' sense of efficacy and student achievement. New York: Longman.

Ashton, P. T., Webb, R. B., & Doda, N. (1983). A study of teacher sense of efficacy. Final Report. Gainesville: University of Florida. ERIC EDRS# ED231833.

Austin, S., Wadlington, E., & Bitner, J. (2001). Effect of beliefs about mathematics on math anxiety and math self-concept in elementary teachers. Education, 112(3), 390-396.

Ball, D. L. (1996). Teacher learning and the mathematics reforms: What we think we know and what we need to learn. Phi Delta Kappan, 77, 500-508.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. Psychological Review, 84, 191-215.

Bandura, A. (1986). Socialfoundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). Self-Efficacy: The Exercise of Control. New York: W.H. Freeman and Company.

Battista, M. T. (1994, February). Teacher Beliefs and the Reform Movement in Mathematics Education. Phi Delta Kappan, 462-470.

Black, T. R. (1999). Doing quantitative research in the social sciences: An integrated approach to research design, measurement, and statistics. Thousand Oaks, CA: SAGE Publications, Inc. (p. 118)

Bogdan, R. C., & Biklen, S. K. (1992). Qualitative research for education. Boston: Allyn and Bacon.

Brady, P., & Bowd, A. (2005). Mathematics anxiety, prior experience, and confidence to teach mathematics among pre-service education students. Teachers and Teaching: Theory and Practice, 11(1), 37-46.

Brush, L. L. (1981). Some thoughts for teachers on mathematics anxiety. Arithmetic Teacher, 29, 37-39.

Bursal, M. & Paznokas, L. (2006). Mathematics anxiety and preservice elementary teachers' confidence to teach mathematics and science. School Science and Mathematics, 106 (4), 173-180.

Castillo, J. J. (2009). Convenience sampling. Retrieved on November 20, 2010 from Experiment Resources: http://www.experiment-resources.com/convenience-sampling.html

Cemen, P. B. (1987). The nature of mathematics anxiety. (Report No. SE 048 689). Stillwater, OK: Oklahoma State University. (Eric Document Reproduction Service No. ED 287 729).

Cheung, H.Y. (2006). The measurement of teacher efficacy: Hong Kong primary inservice teachers. Journal of Education for Teaching, 32 (4), 435–451.

Clandinin, D. J., & Connelly, F. M. (2000). Narrative inquiry: Experience and story in qualitative research. San Francisco, CA: Jossey-Bass.

Cohen, R. & Karen Green. (2002, July). Upper Elementary Teachers' Mathematics Related Anxieties and Their Effects on Their Teaching. Proceedings of the 26-th Annual Conference of the International Group for the Psychology of Mathematics Education (PME26), Norwich, 2, 265-272.

Cohen, L., & Manion, L., (1989) (3rd Edition), Research Methods in Education, London: Routledge

Coladarci, T. (1992). Teachers' sense of efficacy and commitment to teaching. *Journal of Experimental Education,* 60, 323–337.

Creswell, J.W. (2003). Research design. Qualitative, quantitative and mixed methods approaches. Thousand Oaks, CA: Sage.

Cuff, C. K. (1993). Beyond the formulas – mathematics education for prospective elementary school teachers. Education, 114, 221-224

Czerniak, C. M. (1990). A study of self-efficacy,anxiety,and science knowledge in preservice elementary teachers. Paper presented at the National Association for Research in Science Teaching, Atlanta, GA.

Dane, F. C. (1990). Research methods, Brooks/Cole Publishing Company

Descombe, M. (1998). The good research guide for small-scale social research projects. Great Britain: Guildford & Kings Lynn

Dossel, S. (1993). Math anxiety. Australian Mathematics Teacher, 49(11), 4-8.

Enochs, L., Smith, P. & Huinker, D. (2000). Establishing factorial validity of the Mathematics Teaching Efficacy Beliefs Instrument. School Science and Mathematics, 100 (4),194-202.

Enon, J. C. (1995). Teacher efficacy: its effects on teaching practices and student outcomes in mathematics. Unpublished doctoral dissertation. University of Alberta.

Emenekar, C. (1996). A problem solving based mathematics course and elementary teachers' beliefs. School Science and Mathematics, 96 (2), 65-71.

Ernest, P. (2000). Teaching and learning mathematics. In Koshy, V., Ernest, P. & Casey, R. (Eds). Mathematics for Primary School Teachers. London, UK, Routeledge.

Evans, E. D., & Tribble, M. (1986). Perceived teaching problems, self-efficacy, and commitment to teaching among pre-service teachers. Journal of Educational Research, 80(2), 81-85.

Fennema, E. (1977). Influence of selected cognitive, affective, and educational variables on sex-reiated differences in mathematics, learning, and studying. (National Institute of Education Papers in Education and Work, No. 8, U.S. Department of Health, Education, and Welfare). Washington, DC: U.S. Government Printing Office.

Fennema, E. & Sherman, J. A., (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments designed to measure attitudes towards the learning of mathematics by males and females. Catalogue of Selected Documents in Psychology, 6 (2) 31.

Flewelling, G. & William, H. (2001). A handbook on rich learning tasks. Centre for Mathematics, Science, and Technology Education, Queen's University, Kingston.

Fox, L. H. (1977). The effects of sex role socialization on mathematics participation and achievement (National Institute of Education Papers in Education and Work, No. 8, U.S. Department of Health, Education, and Welfare). Washington, DC: U.S. Government Printing Office

Furner, M.F., Yahya, N., & Duffy, M.L. (2005). Teach mathematics: Strategies to reach all students. Intervention in School and Clinic. 41, 16-23

Furner, J. M. & Berman, B. T. (2004). Confidence in Their Ability to Do Mathematics: The need to eradicate math anxiety so our future students can successfully compete in a high-tech globally competitive world. Philosophy of Mathematics Education Journal, 18.

Furner, J. M. & Duffy, M.L. (2002). Equity for all students in the new millennium: disabling mathematics anxiety. Intervention in School and Clinic, 38(2), 67-74.

Ghaith, G., & Yaghi, H. (1997). Relationships among experience, teacher efficacy, and attitudes toward the implementation of instructional innovation. Teaching and Teacher Education, 13, 451–458.

Gibson, S., and Dembo, M. H. (1984), Teacher efficacy: a construct validation, Journal of Educational Psychology, 76 (4), 569-582.

Godby, C. (1997). Mathematics anxiety and the underprepared student. (ERIC Document Reproduction Service No. ED 426 734)

Goulding, M., Rowland, T., Barber, T. (2002). Does it matter? Primary teachers trainees' subject knowledge in mathematics. British Educational Research Journal, 28, 689-704.

Gresham, G. (2008). Mathematics anxiety and mathematics teacher efficacy in elementary pre-service teachers. Teaching Education, 19(3), 171-184

Gresham, G. (2007). A study of mathematics anxiety in pre-service teachers. Early Childhood Eduction Journal, 32(2), 181-188.

Guskey, T. R. (1988). Teacher efficacy, self-concept, and attitudes toward the implementation of instructional innovation. Teaching and Teacher Education, 4(1), 63-69.

Hami, J., Czerniak, C., & Lumpe, A. (1996). Teacher beliefs and intentions regarding the implementation of science education reform strands. Journal of Research in Science Teaching, 33, 971- 993.

Harper, N.W. & Daane, C.J. (1998). Causes and reduction of math anxiety in pre-service elementary teachers. Action in Teacher Education, 19(4), 29–38.

Haylock, D. (2003) Mathematics Explained For Primary Teachers. 2nd Edition. London: Paul Chapman.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. Journal for Research in Mathematics Education, 21, 33-46

Hoy, A. W. & Spero, R. B. (2005). Changes in teacher efficacy during the early years of teaching: a comparison of four measures. Teaching and Teacher Education, 21, 343-356.

Hoy, W. K., & Woolfolk, A. E. (1993). Teachers' sense of efficacy and the organizational health of schools. Elementary School Journal, 93, 335–372.

Huinker, D., & Madison, S. K. (1997). Preparing efficacious elementary teachers in science and mathematics: The influence of methods courses. Journal of Science Teacher Education, 8(2), 107-126.

Huinker, D., & Madison, S. (1995). The struggles of Kay and Aaron: Mathematics minors in a constructivist paradigm of elementary mathematics instruction. Paper presented at AERA, San Francisco, CA. (ERIC Document 386 458).

Ingersoll, R.M. (1999). The problem of underqualified teachers in American secondary schools, Educational Researcher, 28(2), 27-37

Jackson, C. D., & Leffingwell, R. J. (1999). The role of instructors in creating mathematics anxiety in students from kindergarten through college. Mathematics Teacher, 92, pp. 583–586.

Johnson, D. (2003). Math anxiety: A literature review. Retrieved September 15, 2010, from http://www.hmboldt.edu/~dlj1/mathLitRev.doc

Kellerman, H. & Burry, A. (2007). Handbook of Psychodiagnostic Testing: Analysis of Personality in the Psychological Report. Springer, New York. Retrieved on April 20 from http://www.springerlink.com/content/jl725l55l6235229/

Kelley, W. P., & Tomhave, W.K. (1985). A study of math anxiety/ avoidance in preservice elementary teachers. Arithmetic Teacher, 32(5), 51-53.

Kennedy, M. M. (1998, April). The relevance of content in in-service teacher education. Paper presented at the annual meeting of the American Educational Reasearch Association, San Diego, CA.

Kennedy, W.A. (1971). Child Psychology. Prentice Hall Inc. Englewood Cliffs, New Jersey

Kennedy, L. & Tipps, S. (1990). Guiding children's learning of mathematics. Belmont, CA: Wadsworth.

Laturner, R.J. (2002) Teachers' academic preparation and commitment to teach math and science. Teaching and Teacher Education, 18, 653-663.

Leedy, P.D. (1997) Practical Research: Planning and Design. 6th ed. New Jersey: Prentice-Hall, Inc.

Levine, G. (1993) Relationships among anxiety for teaching mathematics, prior student history, and expectations for mathematics teaching style among prospective elementary school teachers. Proceedings of the Fifteenth Annual Meeting f the North American Chapter of the International Groups for the Psychology of Mathematics Education, USA, 2, 261

Levine, G. (1993). Prior mathematics history, anticipated mathematics teaching style, and anxiety for teaching mathematics among pre-service elementary school teachers. Paper presented at the Annual Meeting of the International Group for Psychology of Mathematics Education, North American Chapter (ERIC Document Reproduction Service No. ED373972).

Levine, M. D. (1999). Developmental variation and learning disorders. Cambridge, MA: Educators Publishing Service.

Lincoln, Y. S. & Guba, EG. (1985). Naturalistic Inquiry. Newbury Park, CA: Sage Publications.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. Journal for Research in Mathematics Education, 30(2), 520-540.

Malinsky, M., Ross, A., Pannells, T. & McJunkin, M. (2006). Math Anxiety in pre-service elementary school teachers. Education, 127(2), 274-279.

McLeod, D.B., (1993). Research on affect in mathematics education: A reconceptualisation. In D.A. Grouws (Ed.) Handbook of Research on Mathematics Teaching and Learning, Macmillan Publishing Co., London, 75-596.

McMillan, J. H. (2004). Educational research: Fundamentals for the consumer (4th ed.). Boston, MA: Pearson Education.

Merriam, S. B. (1998). Qualitative research and case study applications in education. San Francisco, CA:

Midgley, C., Feldlaufer H., & Eccles J.S. (1989). Change in teacher efficacy and student self and task-related beliefs in mathematics during the transition to junior high school. Journal of Educational Psychology, 81, 247–58.

Nicolaou, A. A. & Phillipou, G. N. (2007). Efficacy beliefs, problem posing and mathemrics achievement. Focus on Learning Problems in Mathematics, 29(4), 48-55.

Orton, A. & Frobisher, L. (1996) Insights into teaching mathematics. London: Continuum.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. Review of Educational Research, 66, 543-578.

Pajares, F. (1999). Current Directions in Self- Efficacy Research. In M. Maehr, & P.R. Pintrich (Eds.), Advances in motivation and achievement. (pp. 1-49). Greenwich, CT: JAI Press.

Patton, M. Q. (1990). Qualitative evaluation and research methods (2nd ed.). Newbury Park, CA: Sage Publications.

Peker, M., (2009). The effects of an instruction using problem solving strategies in mathematics on the teaching anxiety level of the pre-service primary school teachers. The New Educational Review, 19 (3-4), 95-114

Peker, M. (2009). Pre-Service Teachers' Teaching Anxiety about Mathematics and Their Learning Styles. Eurasia Journal of Mathematics, Science & Technology Education, 5(4), 335-345

Perry, A. B. (2004). Decreasing mathematics anxiety in college students. College Student Journal, 38(2), 321–324.

Preis, C. & Biggs, B. T. (2001). Can instructors help learners overcome math anxiety? ATEA Journal, 28(4), 6-10.

Raymond, A. M. (1997). Inconsistency between a beginning elementary school teacher’s mathematics beliefs and teaching practice. Journal for Research in Mathematics Education, 28(5), 550-577.

Resnick, H., Viehe, J., & Segal, S., (1982). Is math anxiety a Local Phenomenon? A study of prevalence and dimensionality. Journal of Counseling Psychology, 29(1), 39-47

Richardson, F. C. & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. Journal of Counseling Psychology, 19, 551-554.

Richards, A., & French, C. C. (1990). Central versus peripheral presentation of stimuli in an emotional stroop task. *Anxiety Research*, 3, 41-49.

Richardson, F. C, &. Woolfolk, R. L. (1980). Mathematics anxiety. In I. G. Sarason (Ed.), Test anxiety: Theory, research and application (pp. 271-288). Hillsdale, NJ: Erlbaum.

Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. Science Education,74, 625-637.

Ross, J. A. (1994), Beliefs that make a difference: the origins and impacts of teacher efficacy. Paper presented at the annual meeting of the Canadian Association for Curriculum Studies, Calgary, Alta, June (ERIC Document Reproduction Service No. 379 216).

Ross, J. A. (1992). Teacher efficacy and the effect of coaching on student achievement. Canadian Journal of Education, 17(1), 51-65.

Scarpello, G. (2007). Helping students get past math anxiety. Association for Career and Technical Education, 82(6), 34-35.

Seaman, R. (1999). I've got a secret: Math anxiety. Philosophy of Mathematics Education Journal, 11. Retrieved on November 3, 2010 from http://people.exeter.ac.uk/PErnest/pomme11/art16.htm

Shields, D. J. (2005). Teaches have tho power to allevieate math anxiety. Academic Exchange Quarterly. Retrieved on October 22, 2010 from http://findarticles.com/p/articles/mi_hb3325/is_3_9/ai_n29219709/

Shore, K. (2005). Math anxiety. Education World. Retrieved on October 20, 2010 from http://www.education-world.com/a_curr/shore/shore066.shtml

Skemp, R.R. (1986). The psychology of learning mathematics Penguin, Harmondsworth

Smith, S. S. (1997). Early childhood mathematics. Boston: Allyn and Bacon.

Smith, B. S. & Smith, W. H. (1997). Coping with math anxiety. Platonic Tealms Minitexts. Retrieved on October 12, 2010 from http://www.mathacadem.com/pr/minitext/anxiety/

Smith, J., & White, P. (2002). An examination of implicitly activated, explicitly activated, and nullified stereotypes on mathematical performance: It's not just a woman's issue. *Sex Roles, 47*(3/4), 179-191.

Soodak, L., & Podell, D. (1993). Teacher efficacy and student problems as factors in special education referral. Journal of Special Education, 27, 66–81.

Sousa, D. A. (2008). How the brain learns mathematics. Thousand Oaks, CA: Corwin Press.

Strauss, A., & Corbin, J. (1998). Basics of qualitative research (2nd ed.). Thousand Oaks, CA: Sage.

Suinn, R. M., & Winston, E. H. (2003). The Mathematics Anxiety Rating Scale, a brief version: Psychometric data. *Psychological Reports*, 92, 167-173.

Suinn, R. M., Edie, C. A., Nicoletti, J., & Spinelli, P. R. (1972). The MARS, a measure of mathematics anxiety: Psychometric data. Journal of Clinical Psychology, 28, 373-375.

Swars, S. L. (2004). Mathematics teaching efficacy beliefs of elementary preservice teachers and their relationship to mathematics anxiety. Unpublished doctoral dissertation, University of Alabama.

Swars, S. L. (2007). Examining perceptions of mathematics teaching effectiveness among elementary pre-service teachers with differing levels of mathematics teacher efficacy. Journal of Instructional Psychology, 32(2), 139-147.

Swars, S. L., Daane, C. J. & Giesen, J. (2006). Mathematics anxiety and mathematics teacher efficacy: What is the relationship in elementary preservice teachers? School Science and Mathematics, 106 (7), 306-315

Swetman, D. L. (1991). Fourth grade math: The beginning of the end? Journal of Reading Improvement. 94(3). 173-176.

Tankersley, K. (1993). Teaching math their way. Educational Leadership, 50, 12-13.

Taylor, B. A., & Fraser, B. J. (2003). The influence of classroom environment on high school students' math anxiety. Paper presented at the Annual Meeting of the American Educational Research Organization, Chicago, IL.

Thompson, A.G. (1984). The relationship of teachers' conceptions of mathematics and mathematics teaching to instructional practice, Educational Studies in Mathematics, 15(2),105-109

Tobias, S. (1977). Math anxiety. Teacher, 71-74

Tobias, S. (1978). Managing math anxiety: A new look at an old problem. Children Today, 7(5), 36

Tobias, S., & Weissbrod, C. (1980). Anxiety and mathematics: An update. Harvard Educational Review, 50, 63-70.

Tobias, S. (1987). Succeed with math: Every student's guide to conquering math anxiety. New York: College Board Publications.

Tobias, S. (1993). Overcoming math anxiety. New York: W. W. Norton & Company.

Tocci, C., & Engelhard, G. (1991, May). Achievement, parental support, and gender differences in attitudes toward mathematics. *Journal of Educational Research, 84*(5), 280-286.

Tooke, D. J. & Lindstrom, L. C. (1998). Effectiveness of a mathematics methods course in reducing math anxiety of preservice elementary teachers. School Science and Mathematics, 98(3), 136-139.

Trice, A. D., & Ogden, E. D. (1986). Correlates of mathematics anxiety in first-year elementary school teachers. Education Research Quarterly, 1, 2-4.

Trujillo, K. M. & Hadfield, O. D. (1999). Tracing the roots of mathematics anxiety through in-depth interviews with preservice elementary teachers. College Students Journal, 33(2), 219-332

Tschannen-Moran, M & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct.. Teaching and Teacher Education, 17, 783-805.

Uusimaki, L.. & Nason, R. (2004). Causes underlying pre-service teachers' negative beliefs and anxieties about mathematics. Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education, vol. 4, 369-376. (ERIC Document Reproduction Service No. ED489664).

Vinson, B. M. (2001). A comparison of preservice teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. Early Childhood Education Journal, 29, 89-94.

Vinson, B. M., Haynes, J. Brasher, J. Sloan, T. & Gresham, T. (1997). A comparison of preservice teachers' mathematics anxiety before and after a methods class emphasizing manipulatives (ERIC Document Reproduction Service No. ED 417 136)

Wenner, G. (2001). Science and mathematics efficacy beliefs held by practicing and prospective teachers: A five-year perspective. Journal of Science Education and Technology, 10, 181–187.

Wenta, R. G. (2000). Efficacy of preservice elementary mathematics teachers. Unpublished doctoral dissertation. Indiana University.

Wheatley, K. F. (2005). The case for reconceptualizing teacher efficacy research. Teaching and Teacher Education, 21, 747-766.

Williams, W. V. (1988). Answers to questions about math anxiety. School Science and Mathematics, 88, 95-104.

Woolfolk, A., Rosoff, B., & Hoy, W. (1990). Teachers' sense of efficacy and their beliefs about managing students. Teaching and Teacher Education, 6, 137-148.

Wright, D. E. & Miller, L. D. (1981). Math anxiety: A research report. (ERIC Document Reproduction Service No. ED 212 465)

Appendix A – Introductory Letter

Dear Colleague,

My name is Sharon Jaggernauth. I am pursuing a Masters in Education at The University of the West Indies, St. Augustine. I am conducting research into mathematics anxiety and mathematics teacher efficacy among primary school teachers in Trinidad and Tobago This study is designed to collect data via a survey-type questionnaire.

You are invited to participate in this research. Your agreement to participate means that you have voluntarily agreed to complete and return the questionnaire that accompanies this introductory letter.

All information that you provide on this questionnaire will be respected, and will remain strictly confidential. The information will not be shared with anyone besides the researcher, and will be stored securely. No references to your identity will be made that may connect you to this study. This data is being anonymously collected.

Your participation in this study is greatly and sincerely appreciated. Your participation is strictly voluntary and you may withdraw at any time with no consequences to you or your employment. Your involvement, however, is critical to the success of this study, which aims to add to the local and regional literature in mathematics education.

Thank you for contributing to research in mathematics education in Trinidad and Tobago.

Partners in education,

Sharon Jaggernauth

Please indicate below, your willingness to participate in this study:

☐ I am willing to participate in the study. I understand that all information collected from me will remain confidential.

☐ I prefer not to participate in the study.

Date ________________________________

Appendix B – Mathematics Beliefs Questionnaire

Dear Colleague,
Before completing this questionnaire indicate your willingness to participate in this study and write in the date in the space provided on the attached introductory letter. Please carefully read the instructions for responding to the items in this questionnaire and respond to them as honestly and precisely as you are able to. This questionnaire consists of 33 items and three (3) pages.
This questionnaire has two sections: Section A seeks information about your background; Section B seeks information about your experiences with mathematics and your beliefs about teaching mathematics.
Once you have completed the questionnaire, check it through to ensure that your responses to each accurately reflect what you want to communicate, and return to questionnaire to the manila envelope.
I thank you for your voluntary participation in this study, and assure you that all the information that you have provided me will be securely stored and not shared with any other individual or organization.

Section A - Background Information

This section requires some of your background information. Please fill in as accurately as you can by either ticking the appropriate box, where appropriate, or writing in the requested information.

1. Gender: ☐ Male ☐ Female
2. Age group: ☐ 18 – 29 yrs ☐ 30 – 39 yrs ☐ 40 – 49 yrs ☐ 50 – 59 yrs
3. Highest level of education achieved (select only one):
   - ☐ Only secondary school certification (CXC / CSEC / GCE, etc______ (please specify)
   - ☐ Certificate in Education ☐ Teachers College Diploma
   - ☐ Bachelor in Education ☐ Masters / Doctorate
   - ☐ Other ____ (please specify)
4. Grade earned at O Level mathematics: ____
5. Number of years teaching: __________________ years
6. Educational district where you teach:
   - ☐ Caroni ☐ North Eastern ☐ Port of Spain ☐ South Eastern
   - ☐ St. George East ☐ St. Patrick ☐ Tobago ☐ Victoria
7. School type: (i) ☐ Government ☐ Government-assisted
   (ii) ☐ Girls only ☐ Boys only ☐ Both boys and girls
8. Age group you currently teach:
   - ☐ Infants I ☐ Infants II ☐ Standard 1 ☐ Standard 2
   - ☐ Standard 3 ☐ Standard 4 ☐ Standard 5 ☐ Post Primary
9. Length of time teaching the level you currently teach: _______________________________

10. If you possess a Certificate in Education, area of specialization: ______________________
11. If you possess a Teachers College Diploma, area of specialization: ____________________
12. If you possess a Bachelor in Education, area of specialization: ________________________
13. If you possess a Masters in Education (or higher), area of concentration: _______________
14. Currently pursuing in a programme of study, please indicate the level, and the institution:

    Programme level: ☐ Certificate ☐ Diploma ☐ Bachelor ☐ Masters/Doctorate

Section B – Teacher Beliefs about Mathematical

Please use the following key to circle/shade only one appropriate response for each statement below:

SD = Strongly Disagree D = Disagree A = Agree SA = Strongly Agree

1	I almost never get uptight while taking a math test.	SD	D	A	SA
2	I didn’t take math in my last year of secondary school.	SD	D	A	SA
3	I continually find better ways to teach mathematics.	SD	D	A	SA
4	Mathematics makes me feel uneasy and confused.	SD	D	A	SA
5	I know how to teach mathematics concepts effectively.	SD	D	A	SA
6	I get really uptight during math tests.	SD	D	A	SA
7	I look forward to teaching math.	SD	D	A	SA
8	Math makes me feel uncomfortable and nervous.	SD	D	A	SA
9	I have taken math classes even thought they were not required.	SD	D	A	SA
10	It would not bother me at all to take more math courses.	SD	D	A	SA
11	I don’t want to teach math in the future.	SD	D	A	SA
12	I understand math concepts well enough to effectively teach math.	SD	D	A	SA
13	I avoided taking math classes after leaving secondary school.	SD	D	A	SA
14	I have usually been at ease during math tests.	SD	D	A	SA
15	I have dropped math courses because they became too difficult.	SD	D	A	SA
16	I am typically able to answer students' questions.	SD	D	A	SA
17	I have usually been at ease during math courses.	SD	D	A	SA
18	When teaching math, I usually welcome student questions.	SD	D	A	SA

19	I have selected math as my area of emphasis.	SD	D	A	SA
20	I'm not very effective in monitoring students’ math activities.	SD	D	A	SA
21	My mind goes blank and I can't think clearly when doing math.	SD	D	A	SA
22	I generally teach math ineffectively.	SD	D	A	SA
23	I elected to take part in math competitions.	SD	D	A	SA
24	I find it difficult to use manipulatives to explain to students why math works.	SD	D	A	SA
25	I don’t believe that l have the necessary skills to teach math.	SD	D	A	SA
26	I get a sinking feeling when I think of trying a hard math problem.	SD	D	A	SA
27	I will not invite the principal to evaluate my math teaching.	SD	D	A	SA
28	I have often helped others with their math homework.	SD	D	A	SA
29	When students have difficulty understanding a concept, I often can't help them understand it better.	SD	D	A	SA
30	I usually don't worry about my ability to solve math problems.	SD	D	A	SA
31	I chose an area of study that didn’t require many math courses.	SD	D	A	SA
32	I do not know what to do to turn students on to math.	SD	D	A	SA
33	Even if I try very hard, I cannot teach math as well as I teach most other subjects.	SD	D	A	SA

☺ You have reached the end. Thank you for completing this questionnaire. ☺

Appendix C – Weighting of Subscales

REVISED MATHEMATICS ANXIETY SCALE - RMAS		SD	D	A	SA
+	It would not bother me at all to take more mathematics courses.	1	2	3	4
+	I have usually been at ease during mathematics tests.	1	2	3	4
+	I have usually been at ease during math courses.	1	2	3	4
+	I usually do not worry about my ability to solve mathematics problems.	1	2	3	4
+	I almost never get uptight while taking a mathematics test.	1	2	3	4
-	I get really uptight during mathematics tests.	4	3	2	1
-	I get a sinking feeling when I think of trying a hard mathematics problem.	4	3	2	1
-	My mind goes blank and I am unable to think clearly when doing mathematics.	4	3	2	1
-	Mathematics makes me feel uncomfortable and nervous.	4	3	2	1
-	Mathematics makes me feel uneasy and confused.	4	3	2	1

PERSONAL MATHEMATICS TEACHING EFFICACY BELIEF - PMTEB		SD	D	A	SA
+	I continually find better ways to teach mathematics.	1	2	3	4
+	I know how to teach mathematics concepts effectively.	1	2	3	4
+	I understand mathematics concepts well enough to effectively teach mathematics.	1	2	3	4
+	I am typically able to answer students' questions.	1	2	3	4
+	When teaching mathematics, I usually welcome student questions.	1	2	3	4
-	Even if I try very hard, I cannot teach mathematics as well as I most other subjects.	4	3	2	1
-	I am not very effective in monitoring students' mathematics activities.	4	3	2	1
-	I generally teach mathematics ineffectively.	4	3	2	1
-	I find it difficult to use manipulatives to explain to students why mathematics works.	4	3	2	1
-	I don't believe that l have the necessary skills to teach mathematics.	4	3	2	1
-	Given a choice, I will not invite the principal to evaluate my mathematics teaching.	4	3	2	1
-	When a student has difficulty understanding a concept, I often cannot help them understand it better.	4	3	2	1
-	I do not know what to do to turn students on to mathematics.	4	3	2	1

MATH AVOIDANCE SCALE – MAS		SD	D	A	SA
+	I look forward to teaching math.	1	2	3	4
+	I elected to take part in math competitions.	1	2	3	4
+	I have selected math as my area of emphasis.	1	2	3	4
+	I have often helped others with their math homework.	1	2	3	4
+	I have taken math classes even thought they were not required.	1	2	3	4
-	I don't want to teach math in the future.	4	3	2	1
-	I didn't take math in my last year of secondary school.	4	3	2	1
-	I avoided taking math classes after I left secondary school.	4	3	2	1
-	I chose an area of study after secondary school that didn't require me to take many math courses.	4	3	2	1
-	I have dropped math courses because they became too difficult.	4	3	2	1