Effective Strategies to Reduce Math Anxiety in Teachers and Students

By

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Abstract

The purpose of this research project is to develop ways to effectively reduce math anxiety in both teachers and students. This study explores the strategies teachers currently use to reduce the level of anxiety that they face in doing and teaching mathematics, as well as to prevent challenges that students face in learning mathematics. Data was collected through semi-structured interviews with three in-service teachers from the Greater Toronto Area. The sample of teachers used in this study was purposefully selected to ensure they either experienced math anxiety or contained knowledge about math anxiety. Findings suggest that some methods can help reduce teachers’ anxiety in mathematics. They include: promoting group work, using a student-centered approach, use of technology and manipulatives to engage students, creating an open dialogue with students about math anxiety, journaling and self-reflecting on lessons for improvements, detailed planned lessons, and becoming more familiar with the content of the mathematics curriculum. Educators in this study suggest that applying these tactics can also benefit and decrease students’ anxiety.

Key Words: math anxiety, math teaching anxiety, support options, coping strategies
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>2</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>3</td>
</tr>
<tr>
<td>Chapter 1: Introduction</td>
<td>7</td>
</tr>
<tr>
<td>1.0 Research Context</td>
<td>7</td>
</tr>
<tr>
<td>1.1 Research problem</td>
<td>9</td>
</tr>
<tr>
<td>1.2 Purpose of the Study</td>
<td>10</td>
</tr>
<tr>
<td>1.3 Research Questions</td>
<td>11</td>
</tr>
<tr>
<td>1.4 Background of the Researcher</td>
<td>12</td>
</tr>
<tr>
<td>1.5 Overview</td>
<td>14</td>
</tr>
<tr>
<td>Chapter 2: Literature Review</td>
<td>16</td>
</tr>
<tr>
<td>2.0 Introduction to the Chapter</td>
<td>16</td>
</tr>
<tr>
<td>2.1 Math Anxiety Defined and Explored</td>
<td>16</td>
</tr>
<tr>
<td>2.1.1 Definitions of Math Anxiety</td>
<td>16</td>
</tr>
<tr>
<td>2.1.2 Probable Causes Underlying Teachers’ Negative Beliefs Towards Math</td>
<td>17</td>
</tr>
<tr>
<td>2.2 The Construct of Math Teaching Anxiety</td>
<td>19</td>
</tr>
<tr>
<td>2.2.1 Math Anxiety Among In-service and Pre-service Teachers</td>
<td>21</td>
</tr>
<tr>
<td>2.3 Teachers’ Influence on Students’ Math Anxiety Level</td>
<td>22</td>
</tr>
<tr>
<td>2.3.1 Teachers’ Mathematics Content Knowledge</td>
<td>22</td>
</tr>
<tr>
<td>2.3.2 Consequences of Transmitting Math Teaching Anxiety to Students</td>
<td>22</td>
</tr>
<tr>
<td>2.4 Effective Approaches of Coping with Math Anxiety</td>
<td>24</td>
</tr>
</tbody>
</table>
2.4.1 Strategies for Reducing Math Anxiety 24
2.4.2 Programs and Courses to Reduce Math Anxiety 26
2.5 Conclusion 28

Chapter 3: Research Methodology 29
3.0 Introduction 29
3.1 Research Approach and Procedures 29
3.2 Instruments of Data Collection 30
3.3 Participants 32
   3.3.1 Sampling Criteria 32
   3.3.2 Participant Recruitment 33
   3.3.3 Participants Biographies 34
3.4 Data Analysis 35
3.5 Ethical Review Procedures 35
3.6 Methodological Limitations and Strengths 36
3.7 Conclusion 37

Chapter 4: Research Findings 39
4.0 Introduction to the Chapter 39
4.1 Factors Influencing Math Anxiety 39
   4.1.1 Participants’ Frustration with Teaching Math 40
   4.1.2 Participants’ Responses to Conveying Mathematical Concepts 41
   4.1.3 Participants’ Knowledge of Mathematical Content 43
Chapter 1: Introduction

1.0 Research Context

*I hate math* is a common phrase heard by many teachers when teaching a mathematics class. In Ontario, both mathematical literacy and language literacy are valuable in the education system, however, for most people it is easier to openly proclaim their difficulties and disinterest in math, than reading or writing. Oddly enough, there seems to be a general agreement by many students of all ages, regarding the difficulty of being successful in mathematics, in comparison to other subjects. Since the anxiety experienced when doing math is a more common occurrence, the primary purpose of this research is to investigate teacher pedagogy in support of educators developing strategies to address these challenges.

With regards to education, mathematics is a subject essential for many professional occupations such as “engineering, medicine, science, and education” (Boyd, W., Foster, Smith, & Boyd, W.E., 2014). Often when people struggle to understand and apply mathematical concepts and problems, their options for future career decisions can be limited (Hembree, 1990). The struggles students have in tackling mathematical concepts can stem from a younger age, where students may have experienced anxiety growing up. Additionally, both students’ lack of confidence (Blazer, 2011) and pre-service teachers’ lack of confidence in teaching mathematical concepts can create feelings of anxiety (Bursal & Paznokas, 2006). While this paper will refer to this type of discomfort as math anxiety other commonly used phrases for this problem include “quantiphobia, mathophobia, math phobia, and Mathematics Learning Distress” (Iossi 2007).

Unfortunately, mathematics has emerged as a challenge for many educators and students situated in Ontario due to poor unfortunate standardized scores compared to other countries (The Globe and Mail, 2016). Caroline Alphonso, an education reporter for *The Globe and Mail*, says
that “Math scores in Ontario have been falling as more and more students struggle to meet provincial standards, according to test results” (2016). As a result, in April 2016, Liz Sandals who is Ontario’s Education Minister, announced a $60 million plan to improve math training in elementary schools and made it a requirement for every school to have up to three math specialists to support teachers and parents. In particular, elementary school teachers are required to deliver at least 60 minutes of mandatory math instruction daily, which is the first time the government is allocating a compulsory limit to a core subject. The understanding behind these poor results can mean two things: 1) the majority of citizens, including graduates of teacher’s college, lack the mathematical skills and techniques to effectively teach their students the curriculum expectations, and/or 2) the support and resources may not be available for teachers to effectively teach all students.

Studies conducted on math anxiety are targeted to different groups of people. Most researchers conducted their study with K-12 students (Hembre, 1990; Woodard, 2004; Iossi, 2007), pre-service teachers (Vinson, 2001; Sloan, Daane, & Giesen, 2002; Uusimaki & Nason, 2004; Lubinski & Otto 2004; Bursal & Paznokas, 2006; Liu, 2008; Brown, Westenskow, Moyer-Packenham, 2011; Boyd et al. 2014), and in-service elementary and middle school teachers (Hadley & Dorward, 2011). The intent of this research is to discover educational practices that may benefit both teachers and students to cope with their anxiety.

According to Boyd et al. (2014), “there is a strong societal expectation that teachers themselves will be competent at mathematical skills, have a deep understanding of mathematics, and be able to teach effectively so that their students are successful in mathematics” (p. 208). It is widely accepted that educators carry the qualities of having a good understanding and knowledge of mathematics, and confidence in the ability to learn mathematics (Boyd et al.,
Although it is essential for an elementary teacher to attain these skills and teach the required curriculum expectations with full mathematical competence (Wilson, 2009), this may not always hold true as many teachers face the challenges of being math-anxious themselves (Brown et al. 2011; Hadley & Dorward, 2011; Finlayson, 2014; Boyd et al., 2014). Specifically, tackling the issue of math anxiety that in-service middle school teachers experience may help to address the problem of student math anxiety.

1.1 Research Problem

Math anxiety can affect both students and teachers. For most people, it can begin as early as Grade 3 or 4, where students struggle to understand a mathematical concept, and subsequently find themselves frustrated by their lack of success with that mathematical concept. This may lead to the development of a phobia and/or feelings of hatred towards mathematics (Jackson & Leffingwell, 1999; Hembree, 1990). Math anxiety reactions range from mild to severe, resulting in a variety of feelings, such as panic, distress, flurry, avoidance, fear of failure, a blank mind, and helplessness (Arem, 2003). Although all students experience some sort of math anxiety, the overall level of math anxiety appears to be greater in females than in males (Ma & Cartwright, 2003). Jackson and Leffingwell (1999) discovered that “girls were often ridiculed for not understanding the material” and “when girls asked questions, some teachers laughed at them or told them in class that they were stupid” (p.584). In addition, regardless of ability, girls were generally told to not take mathematics classes (Jackson & Leffingwell, 1999).

Given the adverse effects of math anxiety on students and its interference with learning and teaching in a school setting, it is important to identify the causes of this phenomenon. One reason for student anxiety that needs to be tackled and eliminated is the anxiety educators have because it may be transferred to their students (Dunkle, 2010; Chernoff & Stone, 2014; Liu, 2008). This
is consistent with other research findings. Boyd et al. (2014) argued that, “much of the discussion regarding pre-service teachers and mathematics is centered on math anxiety, and if not addressed in the teacher, is thought to be transferred from teacher to student with immediate and long term educational implications” (p. 208). Consequently, math anxiety is a troubling concept because it could very well be the cause of a student’s lack of success in mathematics. Furthermore, while some students may feel that their low achievements are due to their own abilities or inabilities, it may actually be a result of math anxiety in their educators. These research findings open the door to further research in the area of math teaching anxiety and to determine ways of decreasing math anxiety in educators.

1.2 Purpose of the Study

The purpose of this study is to explore the support options for middle school teachers who experience math anxiety in Ontario, Canada. In other words, the goal is to answer the following question: what resources and support are available for middle school teachers so they can overcome their math anxiety? The terms “support” and “resources” used throughout this paper not only refer to instructional practices, but also effective professional development opportunities and administration intervention. Boyd et al. (2014) explained that negative attitudes towards mathematics are found to affect a high proportion of pre-service teachers preparing to enter the education system. Even more troubling is that pre-service teachers with severely high levels of math anxiety can potentially pass their own anxieties to their students (Chernoff & Stone, 2014; Dunkle, 2010; Liu, 2008). This study encourages teachers to eliminate the re-occurring cycle of math anxiety that is happening in our education system by considering implementation of some successful teaching practices.
The alternative purpose of this research is to report and share practices on what should be done to help diminish math (teaching) anxiety. Moreover, any practices that have benefited them can be disseminated and thereby can potentially inform the instructional practices of other teachers, and support them in their teaching. Thus, this research not only provides teachers with knowledge of the support that is available, but also teaches students effective strategies that may lead to an increase in their success in mathematics, and possibly even a liking to the subject.

It is my hope that these findings will also support teachers in a broader context, as reducing their math anxiety affects their students’ achievements and future career choices. I anticipate that the results of my study will assist teachers in creating a positive classroom environment. By gaining awareness of the available support, instead of teachers passing down the anxiety, they will be able foster confidence for mathematics.

1.3 Research Questions

In exploring math anxiety among in-service middle school teachers, the primary question guiding this study is: what support and teaching practices are teachers with math anxiety employing to cope with their anxiety? Sub-questions to further guide this inquiry include:

1. What support is available for teachers both inside and outside the schools when overcoming math anxiety?

2. What are strategies and recommendations to cure the reoccurring cycle of math anxiety? What are teachers doing to prevent passing on their anxiety to their students?

3. What type of teaching structure do these teachers have when teaching mathematics? For example, do they do more whole-work activities or group-work activities? Do they use technology or manipulatives in their lessons?
4. What obstacles and barriers do teachers face when attaining support from the administration of the school?

5. Is the support, if any, working for teachers with math anxiety? And how is it benefiting their students, if at all?

6. What might be some of the reasons why teachers are anxious about teaching mathematics?

1.4 Background of the Researcher

As a student that has completed her honours undergraduate degree in Mathematics for Education, the topic of math anxiety is particularly interesting to me. Growing up in Canada, I noticed that many of my classmates get very nervous and anxious during math classes, and especially before math tests. From grades K-12, I enjoyed math class. This was partly because, as a child, my parents and older siblings taught me the concepts ahead of the class, so I was consistently ahead of others and received great marks. I also really enjoyed working with numbers. In addition, my previous jobs required me to handle money which involved a lot of math content.

However, as I reflected on my experiences, I noticed that there was not much effort and support from teachers to effectively assist students in developing their mathematical skills. Now, whether this was a lack of confidence in teaching the subject or a lack of understanding the topic from the teachers’ side, I will not be able to say for sure. Needless to say, many of my teachers during elementary and middle school did not express the importance of mathematics for our future careers, let alone connect the concepts we learned in class to real world situations we would encounter in the future.
Teachers often used textbooks as the primary source of teaching mathematics and rarely ever did we engage in group discussions and activities or discuss real-world applications. We almost never used manipulatives or technology as a way of learning the mathematical content. Furthermore, our homework usually consisted of questions assigned from the textbook, and hardly did we actually take up those questions. As a result, the confusion of whether we were correct or incorrect in our homework questions carried over to the final assessments. These teaching strategies caused many of my peers to feel nervous because there was a lack of appropriate teaching methods. Seeing this, I always questioned whether or not there was something that teachers could do to help these anxious students with mathematics. More often than not, it was obvious as to the reason for students’ lack of confidence with math, because they were so expressive in their hatred for the subject. My question then was, why did teachers and educators not use this observation as a means of effecting change in their teaching strategies?

I became further drawn to the topic of math anxiety while pursuing my Masters in Teaching at the University of Toronto. I was made aware of two troubling things: 1) most pre-service teachers were nervous and terrified when told to teach math at their practicum placements, and 2) looking for effective math teaching strategies was troublesome for many teachers both pre-service and in-service teachers.

Although I started my research paper journey looking at the causes of students’ math anxiety, it was through conversations with my classmates that I discovered the extent to which math anxiety exists in future teachers and educators as well. This grabbed my interest almost immediately. I was particularly interested in the fact that teachers often have reservations about delivering effective mathematics instruction due to their own negative attitudes towards the subject. In my opinion, it becomes difficult for students to alleviate their anxiety if teachers
struggle with it as well. Therefore, looking at the root cause of math anxiety in students was imperative. In my junior/intermediate cohort, some of my colleagues expressed that one of the worst subjects to teach during their practicums was mathematics. When I asked *why*, their reply was that they did not feel confident about teaching the mathematical concepts. To which my next question was, “Then how will you teach math when you are required to teach it in your own classroom?” I received no reply.

I have therefore pondered over how these feelings may potentially affect future students. This is extremely important to me as a future educator and proponent in the field of education, as I do not want the issue of math anxiety to continue to influence our future educators and students. I hope one day the majority of teachers are able to confidently say, “I enjoy doing math and I cannot wait to teach math at my practicum placements!” I also believe in the power of teamwork and learning from one another, which is why I believe this study will bring forth effective strategies that can help both teachers and students learn to work together to achieve a difficult, but achievable goal.

1.5 Overview

My approach in addressing these questions is a qualitative research study, which uses semi-structured interviews in exploring in-service teachers’ perspectives on math anxiety and ways to cope when one is a victim of math anxiety. In addition, this study explores the available support system and resources that middle school teachers can use to overcome their anxiety. This study is also about effective teaching pedagogies to help teachers with their math anxiety, which in turn may potentially help students with theirs. In chapter one, I introduced my topic of math anxiety and the value of learning mathematics which has a huge influence on students’ career choices and student achievement. In chapter 2, I review the literature on math anxiety in
teachers, consequences of transmitting math anxiety, and lastly, the available support options for teachers. In chapter 3, I review the methodology, which requires one-on-one interviews with educators who have had experience in addressing math anxiety. In chapter 4, I report my research findings, highlighting key discoveries from the interviews. Finally, in chapter 5, I discuss the implications of my findings for educators by elaborating on issues and questions raised from the findings and highlight interesting areas for future research.
Chapter 2: Literature Review

2.0 Introduction to the Chapter

In this chapter, I review the available literature in the areas of math anxiety and how this anxiety can manifest itself in the classroom. I will discuss the best pedagogical approaches that researchers argue can potentially alleviate anxiety in both teachers and students. More specifically, I review themes related to instructional practices pertaining to math teaching anxiety, and external influences that effect teachers’ perception on mathematics. I start by reviewing the literature regarding the definition of math anxiety and math teaching anxiety as these terms are used frequently throughout this study. Since this study focuses on successful practices to teach mathematical concepts effectively, the consequences of transmitting the anxiety to students is outlined in this literature review, including the importance of acquiring high knowledge of math content. Additionally, there will also be an overview of studies focusing on effective teaching practices necessary for a successful classroom environment. The research presented in this literature review mainly comprises of American studies.

2.1 Math Anxiety Defined and Explored

2.1.1 Definitions of Math Anxiety

Math anxiety is known to be a common topic of research in academia related to pedagogy (Gresham, 2007; Liu, 2008; Mutodi & Ngirande, 2014), which is why numerous definitions of math anxiety exists. The most common definition of math anxiety comes from Richardson and Suinn (1972), who describe it as “a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (p. 551, as cited in Boyd et al., 2014, p. 208). A similar definition of math anxiety described by Tobias and Weissbrod (1980), and Fiore (1999) is, “the panic,
helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem” (as cited in Mutodi & Ngirande, 2014, p. 283).

Recently, Sheila Tobias (2013) describes math anxiety as, “a response, over time, to stress in the math classroom where tests are frequently given under time pressure, in the home where there is competition with siblings, or at the workplace” (as cited in Finlayson, 2014, p.100). While each definition is slightly different, they are all referring to the idea of developing a concern for applying mathematical concepts.

2.1.2 Probable Causes Underlying Teachers’ Negative Beliefs Towards Math

Math anxiety is perceived to be a learned response, but it can be unlearned by exploring what exactly causes it to become triggered (Mutodi & Ngirande, 2014; Liu, 2008) as well as strategies that can be implemented by teachers, students, parents, etc. to overcome the anxiety. As a result, it is highly important to not only learn about the topic of math anxiety but also learn students’ behaviour to see what type of support is needed to alleviate their anxiety. Furthermore, Harper and Daane (1998) believe that attitudes towards learning mathematics are a result of the way the subject is taught, and thus math anxiety in students might be due to the forms of mathematics teaching. Therefore, math anxiety may begin from teacher-related behaviours which is unalterable on the parent part.

A study investigating the causes of math anxiety and identifying strategies used by pre-service teachers to overcome math anxiety was conducted by Maureen Finlayson (2014). The study included 70 pre-service teachers’ surveys’. According to Finlayson (2014), causes of math anxiety include, “lack of self-confidence, fear of failure; teaching styles; ineffective learning practices, and non-engagement of students” (p. 99). In addition, Finlayson suggests generating a greater understanding of mathematical concepts and confronting math anxiety may potentially
ease it (2014). Other causes of math anxiety include, ineffective test-taking strategies, planning unsuccessful tests, psychological pressures (Arem, 2003), “lack of teachers’ consideration of different learning styles among students” (Mutodi & Ngirande, 2014, p. 285), previous behaviors and attitudes of teachers, past experiences of doing poorly in mathematics (Bekdemir, 2010; Boyd et. al, 2014), and the pedagogical methods of teaching mathematics (Gresham, 2007).

A study examining the causes underlying a sample of eighteen third-year pre-service teachers highlighted three origins of negative beliefs and anxiety in regards to mathematics (Uusimaki & Nason, 2004). The three categories include: environmental, intellectual, and personality factors. “Environmental factors include negative experiences in the classroom, parental pressure, insensitive teachers, mathematics being taught in a traditional manner as rigid sets of rules and non-participatory classrooms” (Uusimaki & Nason, 2004, p. 370). Examples of “intellectual factors include being taught with mismatched learning styles, student attitude and lack of persistence, self-doubt, lack of confidence in mathematical ability and lack of perceived usefulness of mathematics” (Uusimaki & Nason, 2004, p. 370). While, examples of personality factors are shyness, low self-esteem and females perceiving “mathematics as a male domain” (Uusimaki & Nason, 2004).

Uusimaki and Nason (2004) found that pre-service teachers feel a huge load of stress when they are in practicum situations and are required to teach mathematics. They speculated that “many negative beliefs held by teachers can be traced back to the frustration and failure in learning mathematics caused by unsympathetic teachers who incorrectly assumed that computational processes were simple and self-explanatory.” (p. 370) According to Uusimaki & Nason (2004), many teachers’ math anxiety and negative beliefs often stems from having a weak mathematical background, prior school experiences, the influence of prior teachers and
experiences in teacher preparation programs, as well as prior teaching experiences (Uusimaki & Nason, 2004; Brown, Westenskow, & Moyer-Packenham, 2011). They concluded that participants felt most anxious about mathematics when they had to communicate their mathematical knowledge in some way, such as through tests and verbal explanations when teaching in front of the classroom. Exactly two thirds of the participants believed their negative beliefs and anxiety towards mathematics emerged in primary school. Most of the participants specifically identified primary school teachers for their learned dislike and fear of mathematics (Uusimaki, & Nason, 2004). Thus, teachers' personal school experiences, especially at the elementary and middle school level, may have been the root cause of their attitudes towards the subject, which resulted in math anxiety (Uusimaki & Nason, 2004). Teachers’ beliefs and attitudes, that is their self-efficacy, about the nature of mathematics, play a huge role in the achievement and success of their students (Uusimaki & Nason, 2004). Last, the study discovered that the anxiety may also arise from feelings of insecurity or not being able to solve a question correctly (Uusimaki & Nason, 2004). While the causes of math anxiety can be debated, there are a number of commonly agreed upon coping strategies to help students with their distaste and insecurity for the subject.

2.2 The Construct of Math Teaching Anxiety

According to Peker (2009), “Mathematics teaching anxiety can be defined as pre- and in-service teachers’ feelings of tension and anxiety that occurs during teaching mathematical concepts, theories, and formulas or during problem solving” (p.336). Math teaching anxiety is slightly different from math anxiety in the sense that math teaching anxiety “is based on an individual’s anxiety about their ability to teach mathematics” (Brown, Westenskow, & Moyer-Packenham, 2011, p. 2) while math anxiety focuses on an individual’s ability to interact with the
mathematical content in general.

Although, a strong mathematics history and confidence about the mathematical knowledge is closely linked to math anxiety, one can still experience math teaching anxiety without experiencing math anxiety (Brown, Westenskow, & Moyer-Packenham, 2011). These individuals lack the skills to effectively deliver mathematical concepts to their students in strategic pedagogical ways. Brown et al. (2011) also points out that teachers with math anxiety may seek available support and help from multiple sources, while teachers with no math anxiety but with math teaching anxiety may experience difficulty in finding support. Although, accessing support from outside may be difficult, there are plenty of effective teaching strategies that can reduce math teaching anxiety (Bekdemir, 2010; Boyd et al., 2014; Bursal & Paznokas, 2006; Dunkle, 2010; Sloan 2010; Lubinski & Otto 2004; Gresham, 2007; Liu, 2008; Vinson, 2001).

A study investigating the impact of math anxiety and math teaching anxiety with 692 teacher participants was conducted by Hadley and Dorward (2011). They found that there is a positive relationship between anxiety about mathematics and anxiety about teaching mathematics. According to Hadley and Dorward (2011), “educational administrators would do well to provide opportunities for additional professional development for teachers in NCTM [National Council of Teachers of Mathematics] Standards-based instructional practices and then build a school climate that supports such teaching practices.” (p. 40). They also suggest that the administration assign teachers to specific grade levels within their comfort zone of teaching mathematics.

Catlioglu, Gurbus and Birgin (2014) conducted a study that aimed to provide new evidence from pre-service elementary school teachers and the relationship between factors associated with math anxiety. Catlioglu, Gurbus, and Birgin (2014) discovered that there is a strong correlation
among math anxiety, mathematics achievement, and mathematics attitude. With regards to the administration, authors suggest that they “make available the necessary infrastructure for elementary school counselling to carry out its responsibilities, at the earliest.” (Catlioglu, Burbus, and Birgin, 2014, p. 123).

2.2.1 Math Anxiety Among In-Service and Pre-Service Teachers

Although math anxiety has been an issue for many people, a particular concern exists for math anxiety in teachers. It can be inferred that teachers with math anxiety would generally be afraid to teach math or they may lack the knowledge and/or confidence to encounter math concepts. Most teachers do not have the knowledge and competence to use mathematical language and have a lack of interest in teaching math interactively (Harper & Daane, 1998; Finlayson, 2014). Therefore, their teaching of mathematics may potentially affect student’s professional and personal opportunities. More importantly, it can affect students’ math performance and achievement (Furner & Berman, 2005). Furthermore, the success in teaching mathematics is substantially conditioned by the teacher’s attitudes and beliefs (Cornell, 1999).

According to several research studies, elementary pre-service teachers have higher levels of math anxiety than students majoring in other subject areas (Brown et al., 2011; Hembree, 1990). These pre-service teachers whom are in the process of becoming educators usually portray negative beliefs and experiences of mathematics (Boyd et al., 2014; Lubinski & Otto, 2004). In addition, teachers who have math anxiety are less successful at conveying important mathematical concepts; therefore, their students are lacking these requisites which potentially can affect their academic growth (Adeyemi, 2015; Hadley & Dorward, 2011). Due to the lack of skills and confidence in teaching mathematical concepts, it is very common for teachers to use traditional teaching methods, such as allocating more time for teacher-led lessons and
independent seatwork assignments (Adeyemi, 2015) instead of teacher-led lessons. Having math anxiety as a pre-service teacher can affect one’s current studies but also their future teaching of mathematics to their potential students resulting in math teaching anxiety (Furner & Berman, 2005).

2.3 Teachers’ Influence on Students’ Math Anxiety Level

2.3.1 Teachers’ Mathematics Content Knowledge

According to The National Council of Teachers of Mathematics (NCTM, 2000), teaching mathematics with understanding and comprehension in a classroom setting is the correct approach to pedagogy (Lubinski & Otto, 2004). A child needs to be exposed to mathematical concepts prior to formal schooling (Lago & DiPerna, 2010), and educators of these children require a rich background to properly explain mathematical ideas and support numeracy development. Additionally, “for students to understand mathematical concepts and the nature of the mathematical enterprise, they must engage in investigating, conjecturing, and justifying and then communicate their reasoning and justifications to others” (Lubinski & Otto, 2004, p. 337). Moreover, it is important for teachers to have good understanding and knowledge of mathematics, and confidence in one’s ability to teach mathematics (Wilson, 2009).

2.3.2 Consequences of Transmitting Math Teaching Anxiety to Students

Under this section, I address the literature that looked at the ways in which teachers transmitted their math anxiety to their students. One of the main consequences of math anxiety transferring to students is that these students often make poor academic decisions due to their unsuccessful experience with mathematics, which may limit their career options. A study conducted by Alkan (2013) investigates the methods in which fifty teachers teaching the fourth and fifth grade implement to reduce the level of anxiety that students face in mathematics. He
argues, “teaching methods used in mathematics are expressed as one of the main reasons of creating mathematics anxiety” (Alkan, 2013, p. 796). He discovered that students were anxious when they had problems learning the subject matter. However, if they understood what was taught in the lesson, their anxiety would decrease or be non-existent. Additionally, if there is a positive, encouraging conversation between the teacher and student and a belief in the ability to learn and succeed in mathematics, then students feel there is value and trust in the learning environment. Teachers play a vital role in a child’s education and can influence their attitudes towards mathematics (Alkan, 2013). Since there is a negative relationship between math anxiety and mathematics achievement (Hembree, 1990), teachers must help their students overcome their anxiety or it may cause severe hindrances in their paths to success.

Teachers who experience math anxiety are the least successful at conveying important mathematical concepts which affects students’ academic endeavor. These math-anxious teachers are likely to be anxious about teaching mathematics and are also likely to have lower levels of mathematics teaching self-efficacy (Bursal & Paznokas, 2006). In turn, this anxiety of teachers may be transferred to their students (Bekdemir, 2010; Chernoff & Stone, 2014; Liu, 2008). A project investigated the effect of a standards-based mathematics methods course on the math anxiety levels of pre-service teachers (Sloan, 2010). In his study, Sloan discovers that “math-anxious teachers serve as carriers of math anxiety, passing their own anxieties toward mathematics from one generation to the next” (2010, p. 242).

When students feel afraid and uncomfortable with their inability to do mathematics, they develop math anxiety, which can result in low achievements in mathematics (Ashcraft, 2002). Ashcraft and Moore (2009) argue that “math anxiety is a significant impediment to math achievement, one that affects a considerable portion of the population and one that merits serious
attention both in terms of assessment and intervention” (p.197). Teachers may produce, increase, or reduce math anxiety among their students at all levels of schooling through their attitude, various teaching strategies, and formal instructional practices (Sloan, 2010).

### 2.4 Effective Approaches to Coping with Math Anxiety

#### 2.4.1 Strategies for Reducing Math Anxiety

Iossi (2007) discussed treatment options for reducing math anxiety in post-secondary students. He constructed the categories of “curricular, instructional, and non-instructional strategies for minimizing anxiety levels” (Iossi, 2007, p.30). Curricular strategies he suggests include: “retesting, self-paced learning, distance education, single-sex classes, and math anxiety courses” (Iossi, 2007, p.30). These are strategies that teachers with math anxiety may also access if needed. Iossi notes that instructional strategies include “manipulatives, technology, communication, and self-regulation techniques” (2007, p.30-31). Teachers also need to improve their communication skills on the mathematical concepts in order to reduce math anxiety in them and avoid passing it to their students.

Alkan (2013) states, “It is also necessary for effective teachers to inquire into new teaching strategies to improve pupils’ attitudes, and performances in mathematics to enhance their success” (p. 797). As a result, Alkan’s study (2013) explored teaching strategies implemented by teachers to reduce the level of anxiety students’ face in mathematics. The study concludes:

- to reduce pupils’ anxiety in mathematics, teachers chose such ways as motivating pupils, making math relevant, reviewing the given topic by examples and exercises, using games and also getting support from parents. (Alkan, 2013, p. 797)

It is important for teachers to sustain a welcoming and positive environment where students can discuss concepts in math without being afraid of failing.
As mentioned earlier, Finlayson (2014) discovered some of the best strategies to overcome math anxiety through his study. He encourages teachers to teach using the “constructivist” teaching approach. This approach based on the belief that “learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information” (Constructivist, 2013; cited in Finlayson, 2014; p.102). The strategy consists of having activities that are interactive and student-centered. Students are encouraged to work in groups, use manipulative materials, and engage with technology as primary sources. Additionally, it is important to allow for students to construct a personal understanding based on their prior experiences and reflect on those experiences. With this in mind, it is important to note that the focus of the approach is on the process of problem-solving and on understanding rather than arriving at the correct answer. Such a strategy is validating for diverse learners. Personal strategies mentioned by Finlayson include: relaxation, building self-confidence, practicing, reaching for help, taking risks, occupying diverse teaching strategies and an appropriate pace to teaching, assessment practices and engaging students through videos, math games, manipulatives, and technology (2014). The most effective teaching strategies that teachers can employ is providing encouragement to their students and creating a nurturing environment that allows the student to proceed at their own pace (Posamentier et al., 2010; cited in Finlayson, 2014).

Gundy, Liu, Morton and Kline (2006) explored the effects of web-based instruction on math anxiety, in undergraduate statistics students studying at a University in the northeast United States. There were 175 students enrolled and each received extra credit for participating in the study. Gundy et al. (2006) and Furner and Duffy (2002) examined how using technology can lower math anxiety and increase math self-efficacy. Results of the study suggest that “when
statistics course requirements included the use of WBI techniques, such as Blackboard's (Blackboard Inc. 2001) digital drop box and online student discussion board, class levels of math anxiety were reduced from the beginning (Time I) to the end (Time II) of the course instruction periods” (Gundy et al., 2006, p. 370). In addition, student participation in online discussion forums showed that self-esteem levels improved (Gundy et al., 2006, p. 370).

Other methods of learning outlined include using T-charts, math journals, self-reflections, and surveys (Furner & Duffy, 2002). Another important method for teachers to implement is communicating with their students to fully understand their issues and create realistic ways of combating the issues (Furner & Duffy, 2002). On the contrary, Yushau’s findings on a similar study involving web-based learning tell us otherwise (2006). He discovered that the use of any type of web-based tools is not effective at reducing math anxiety in students. Due to conflicting evidence on this subject, more research needs to be done to determine the true effects of technology on education.

2.4.2 Programs and Courses to Reduce Math Anxiety

A study by Liu (2008) investigating the impact of online discussion on elementary teachers’ anxiety found that the participants’ anxiety reduced significantly post-discussion with other math-anxious teachers. According to Liu (2008),

there was a significant difference between a participant’s level of ATTM [anxiety towards teaching mathematics] before and after online discussion on three constructs: anxiety caused by the conception that mathematics is more difficult, anxiety towards other people’s perception of one’s teaching of mathematics, and anxiety towards teaching in general. (p. 619)
Liu (2008) indicated that online discussion can reduce elementary teacher’s anxiety towards teaching mathematics.

An article by Lubinski and Otto (2004) raises the issue of the lack of experience that pre-service teachers have when learning mathematics in a standard-based classroom. They created a mathematics content course that would provide the pre-service K-8 teachers an opportunity to not only learn mathematics, but also experience what it would be like to teach mathematics. In other words, the content course is designed in such a way where pre-service teachers get exposure to the pedagogy in the Principles and Standards for School Mathematics (National Council of Teachers of Mathematics, 2000; cited in Lubinski & Otto, 2004). Furthermore, the study describes students’ pre- and post-course beliefs, attitudes, and perceptions of what it means to learn and teach mathematics. According to Lubinski and Otto, the findings of the study show that as a result of this course, pre-service teachers were moving from traditional beliefs about how mathematics is learned and taught, towards more standards-based beliefs (2004). The article notes that the course content and experiences have deepened some pre-service teachers’ understanding of the mathematical contents they would be teaching. However, no justification was made on whether the course helped those pre-service teachers in reducing their math anxiety. If teachers can become more comfortable in teaching mathematical concepts through methods such as the one employed in this study, then one can make the inference that these teachers are likely fear math less (Lubinski and Otto, 2004).

There are several studies highlighting successful courses teachers can participate in to alleviate their math anxiety. Emenaker (1996) examined the impact of a problem-solving based mathematics contents course for pre-service elementary education teachers. According to Emenaker, “the course uses a problem-solving approach to help pre-service teachers gain an
understanding of the mathematics they will be required to teach in elementary schools.” (1996, p. 76). He concluded that the problem-solving approach to teaching mathematics to pre-service teachers does have a positive impact on the participants’ mathematical beliefs.

In a similar way, studies by Gresham, Haynes, Sloan, and Vinson (1997) and Vinson (2001) discovered that the use of a hands-on manipulatives approach to a mathematics methods course resulted in a significant decline in math anxiety. Gresham et al. (1997) investigated changes of pre-service teachers’ math anxiety before and after a methods course highlighting manipulatives. “The changes were a function of using: (a) Bruner’s framework of developing conceptual knowledge before procedural knowledge, and (b) manipulatives to make mathematics concepts more concrete” (Gresham et al., 1997, p. 3). Overall, when comparing the group means for the pretest and the posttest scores, it was discovered that math anxiety was significantly reduced. However, some students experienced an increase in math anxiety mainly due to the fact that the participants never used manipulatives with mathematics before. Re-learning mathematics at the same time as learning how to use manipulatives was difficult for participants (Gresham et al., 1997).

2.5 Conclusion

To conclude, in this literature review I have discussed the methodology for this research study. I examined the various definitions and causes of math anxiety and math teaching anxiety. I elaborated on the consequences of teachers transmitting math teaching anxiety to their future students, and mentioned support options and teaching strategies to reduce math anxiety. Next, in chapter 3, I plan to elaborate on the research methodology of this study.
Chapter 3: Research Methodology

3.0 Introduction

In this chapter I describe the research methodology which explores preventative math anxiety strategies and what teaching pedagogies are teachers applying to alleviate not only their anxiety but also their students’ anxiety. I begin by describing the research approach and procedure that I took during this study. Next, I introduce the interviewees of the study, who were chosen to represent the existence of math teaching anxiety in middle school teachers. Then, I describe the sampling criteria and sampling procedures for the study. Later, I describe my approach to analyzing the data and identifying relevant ethical issues. I will describe some of the methodological limitations of this study, such as the limited sample of teachers interviewed, however, identifying the strengths of the study as well. Lastly, I conclude the chapter with an summary of significant methodological decisions.

3.1 Research Approach and Procedures

This study is conducted using a qualitative research study approach. It includes a review of the existing literature related to the research questions for the purpose of the study. Semi-structured, face-to-face interviews with three in-service teachers situated in Ontario is conducted. All three participants are middle school teachers who have knowledge about math anxiety and/or experience some level of math anxiety. Two of the three teachers have personally struggled with math anxiety and math teaching anxiety while the third participant provides effective teaching approaches from the perspective of someone who does not struggle with math (teaching) anxiety.

While this study is a qualitative approach, Carr (1994) believes that neither a quantitative nor qualitative approach is superior to the other, rather they serve different purposes. Quantitative research is when the researcher relies on numerical data, a set of finite questions,
forced-choice responses while qualitative research relies on in-depth responses involving their understanding and creation of prior experiences (Jackson II, Drummond, & Camara, 2007). According to Marshall (1996) “Qualitative studies aim to provide illumination and understanding of complex psychosocial issues and are most useful for answering humanistic ‘why?’ and ‘how?’ questions” (p. 522). Jackson et al. (2007) describe a qualitative research as a “humanistic, interpretive approach” where understanding of human experiences are valuable (p. 23). In other words, “qualitative researchers are often more concerned about uncovering knowledge about how people think and feel about the circumstances in which they find themselves than they are in making judgements about whether those thoughts and feelings are valid” (Thorne, 2000, p. 68).

A qualitative research approach is the most appropriate approach for this study, as it allows me to inquire about the personal experiences and prior experiences of math anxious teachers. My research not only focus on teachers experiencing math anxiety but also how these teachers cope with their insecurities and what type of support and resources are available for their use in the Greater Toronto Area. As a result, resources for teacher support in Ontario is one of the major goal of this study as most studies are American-based research. My goal is to broaden the literature that is available for educators. Therefore, this study brings forth the positive and negative experiences of teachers in mathematic class and how and where can teachers with math anxiety obtain their support.

3.2 Instruments of Data Collection

For collecting qualitative data, interviews are the most meaningful strategy (DiCicco-Bloom & Crabtree, 2006, p. 314). Interviews can be categorised in a variety of ways from highly structured to unstructured, but most often using an approach that falls somewhere in between the
two, called the semi-structured approach (DiCicco-Bloom & Crabtree, 2006; Merriam, 2002). I focused on semi-structured formats because structured interviews often produce quantitative data (DiCicco-Bloom & Crabtree, 2006). Semi-structured interviews have many positive outcomes, such as logic of peoples’ decisions, reasons for their behaviours, attitude and the impact on their lives (Raworth, Sweetman, Narayan, Rowlands, & Hopkins, 2012).

“Semi-structured in-depth interviews are the most widely used interviewing format for qualitative research and can occur either with an individual or in groups” (DiCicco-Bloom & Crabtree, 2006, p. 315). Oftentimes, semi-structured open-ended, informal interviewing is chosen to allow for more flexibility and deep connections for both the interviewer and interviewee (Jackson II et. al., 2007). The questions are usually pre-determined, however, additional questions can emerge through the conversation when interviewing (DiCicco-Bloom & Crabtree, 2006).

As a result, a semi-structured interview protocol is the main instrument of data collection used in this study. I conducted three semi-structured informal interviews. Semi-structured interviews are suitable for my research purpose and questions as it encourages interviewees to speak about their personal life situations (Creswell, 2007). In addition, interviewing allows for educators to openly communicate about the structure of the classroom norms and address students’ characteristics. I sent my participants the questions through e-mail, prior to the actual interview. Interview questions are a mix of open and close-ended questions. Also, I asked additional prompt questions depending on the interviewee’s response on the preliminary questions. This is beneficial for me as an interviewer because during the course of the interview, the interviewee may bring up topics that I had not anticipated, allowing more insight into the topic. Furthermore, the three interviews are conducted face-to-face. I organized my protocol
(Appendix B) into 4 sections, beginning with each participant’s background information, followed by questions about their encounter with math anxiety as a teacher, then their experiences and beliefs related to math anxiety, and then concluding with questions regarding support, challenges, and goals/next steps for teacher. Interviewees are not limited in their definitions or scope of support, as this can include any support received for their anxiety, whether it involves in-school programs or out-of-school workshops. Examples of interview questions include:

1. What does math anxiety mean to you?
2. How does math anxiety affect your teaching? How do you think it affects your students?
3. In your opinion, what kinds of attitudes and behaviors are indicators of math anxiety?

3.3 Participants

To gain insight into effective pedagogies of reducing math anxiety, it is important to get perspectives from educators. Teacher participants are selected based on their experiences with math anxiety as well as their experiences with applying practices that best benefit them, as well as their students, cope with their anxiety. I have also included a section wherein I introduce each of the participants and address all methodological decisions that were undertaken once I got a sense of the findings. All names have been replaced with pseudonyms to protect interviewee identities and maintain confidentiality.

3.3.1 Sampling Criteria

The following criteria will be applied to teacher participants:

1. Teachers may experience math anxiety in their teaching years.
2. Teachers have been working in the field of education in a full-time capacity.
3. Participants have more than two years of teaching experience. Different lengths of teaching experience are preferable.

4. Participants work in the Greater Toronto Area.

Since this study comprises a small, selective sample, the participants that I interviewed have experienced or contain knowledge about math anxiety in their teaching years. Furthermore, since my study is looking at support options for teachers who are going through math anxiety, it is important that teachers have faced math anxiety so that they can relate to the research problem. Teachers have been working in the field of education as a full time and they are required to have at least two years of teaching experience. Different lengths of teaching experience are preferable so that I can compare the number of years entered the workforce to their anxiety circumstance and strategies developed. The last criteria for the sample population is that teachers will be employed within the Greater Toronto Area in order to maintain geographical consistency of the small sample. As a Canadian, I prefer the participants to be teaching in Canada since much of the literature I found was American-based, therefore finding strategies in the Canadian context is important to me for my future teaching.

3.3.2 Participant Recruitment

Both the process of selecting an appropriate type of study and the process of sampling depends on the aim of the research question (Marshall, 1996) and must meet the criteria of the data collection strategy (Carr, 1994). Although random sampling, where the nature of the population is defined and all members have an equal chance of selection, is the most common approach, it may not always be the most effective way to develop an understanding of in-depth issues related to human behaviour (Marshall, 1996). Therefore, choosing someone at random to
answer a qualitative question would not be efficient or useful, and so alternative methods are used in this study (Marshall, 1996).

Two approaches were used in recruiting participants. One was convenience sampling, which involves selecting the most accessible participants and therefore is the least costly (Marshall, 1996). Due to my geographical location and existing connections with teachers and pre-service teachers, I found participants in the Greater Toronto Area. Also, I had the opportunity to do my teaching placements in both elementary and secondary schools within the Greater Toronto Area and in both schools, I taught mathematics. Therefore, this is convenient and cost effective for myself and suitable for my interviewees. Second, a convenience sample also known as a purposeful sample approach is used for this study, where a set of criteria is required for each participant to have, before participating in this study. The criteria above means that this study is recruited purposefully to provide meaningful data.

3.3.3 Participants Biographies

1. Den is currently a middle school teacher with twelve years of teaching experience. Den has a degree in history with a minor in religious studies. He is qualified to teach at the primary, junior, and intermediate levels. His primary teachable is history, but he also has the credentials to teach French. Den started his career by being a substitute and long term occasional teacher for 7 years. He then became a full-time teacher and has been for the last four years. He notes that since he has become a full-time teacher, he has encountered mathematics a lot more frequently. Den feels that he has moderate math anxiety.

2. Elisha is currently a middle school teacher with fifteen years of teaching experience. Elisha has a Bachelor’s degree in music with primary to junior qualification. At the
time of the interview, it was Elisha’s second year teaching mathematics. Both years she has been teaching 7th grade mathematics. She did her schooling and attended university in Russia and came to Canada once she was qualified to be a teacher. Elisha feels that her anxiety in mathematics is extremely high.

3. Tran is currently a middle school teacher with sixteen years of teaching experience. Tran earned her credentials in teaching as a physical education teacher. Later in her career, she did further schooling and received her qualifications to teach mathematics. Although Tran did not have her math qualifications from the beginning of her career, she still taught mathematics to her 7th grade students. Tran, unlike Den and Elisha, claims she does not currently have math anxiety.

3.4 Data Analysis

Through reviewing the transcripts of the interviews and coding based on the questions asked in this study, I found key phrases and themes. According to DiCicco- Bloom and Crabtree (2006), template is a frequently used approach that relies on using codes to organize text then arranging text into categories which can gather major themes. Therefore, my analysis involves recording interviews and coding the data for what relates to my research purpose and questions. Subsequently, categorizing related themes and identifying frequent variances in the findings is presented.

3.5 Ethical Review Procedures

This study is completed under the Master of Teaching (MT) program and students are approved by the Research Ethic Board (REB) as part of graduate studies at the University of Toronto. The development of this thesis, was done with the help from such courses as CTL7006: Reflexive Teaching and Research and CTL7015: From Student to Professional as well as the
assistance of my research professor at OISE/UFT. Due to confidentiality purposes, all participants are given a pseudonym and they will be notified of their right to withdraw from participation in the study at any stage. Equally important, participants’ identities as well as any information related to students or their school will remain confidential. This is very important as any negative statement can jeopardise the teachers’ careers and position in the system.

Given the topic of anxiety, there is a possibility that a certain question may produce emotional responses, which could cause the interviewee to feel uncomfortable. I decreased the chances of interviewees feeling uncomfortable by sending the interview questions to participants ahead of time as well as by making sure that they know that they have the right to refrain from answering any question that they do not feel comfortable answering throughout the interview, as well re-stating their right to withdraw from participating from the study.

Additionally, the audio recordings will be stored on my password-protected laptop and will be destroyed after 5 years. All three participants are asked to sign a consent letter (Appendix A) giving their consent to be intervieweed as well as audio-recorded. This consent is essential for the participants to sign as it provides an overview of the study, addresses ethical implications, and states certain expectations of the participant. The semi-structured interviews are each be 45-60 minutes, at a pre-determined time and location.

3.6 Methodological Limitations and Strengths

This study has several limitations. The largest limitation is that the number of participants in this study is small, however a qualitative research generally has a low population validity (Carr, 1994). According to Hinton, “the strength of this approach is seen when the sample is well defined, for then it can be generalized to a population at large” (1987, cited in Carr, 1994, p. 717). Three teachers are interviewed but the participants were chosen specifically based on the
criteria outlined above to ensure a meaningful understanding and perspective of math anxiety. Given the ethical parameters that we have obtained approval for, the MTRP can only involve interviews with educators, and consequently it is not permitted to interview students or parents, ministry members, or to conduct surveys or classroom observations. Which is why I interviewed teachers with at least 2 or more years of teaching experience.

A strength of the study, however, is that the data is coming from the teachers, which allows me to hear their voices in more depth than a survey could allow for. I created an open space for educators to speak about what matters most to them, reflect on their practices, and address their own lived experiences. The interview also gives opportunity for the interviewees to articulate how they conceptualize math anxiety situations in theory and in practice. Although the findings can inform the topic, they cannot necessarily generalize the experience of teachers from a broad spectrum.

3.7 Conclusion

In this chapter, I explained the research methodology for this study. I started with a discussion of the research approach and procedure, exploring the meaning and importance of qualitative research and also highlighting some of its major differences from quantitative research. Next, I described the instruments of data collection and stated that the semi-structured interview approach is the primary source of data, elaborating on its benefits. I then identified the participants of the study, listed the criteria for all the interviewees, and provided a short biography of each participant. Then I described recruitment procedure, which involves purposive sampling and convenience sampling. Next, I explained that I analyzed the data by examining each interview individually, before looking for common patterns and themes throughout the data. Under ethical procedure, I also mentioned the consent form, risks of participation, right to
withdraw at any point in time, and safety of the recorded audios. Lastly, I examined the
methodological limitations of this study, such being unable to interview children or ministry
members or pre-service teachers, and the small sample size. However, the importance of
interviewing teachers and using interviewing as a protocol is also mentioned. In the next chapter,
I report on the findings of the research.
Chapter 4: Research Findings

4.0 Introduction to the Chapter

This chapter presents and discusses the findings that emerged through the data analysis from the three interviews with Ontario teachers. These participants are teachers of middle schools who showed extreme enthusiasm and passion for the topics of math anxiety and math teaching anxiety.

Throughout the study, I was frequently mindful of my research question: what support and teaching practices are teachers with math anxiety employing to cope with their anxiety? In the discussion, connections are drawn between participants’ practices and the research from Chapter 2’s literature review. Findings are organized into four main themes:

1. Factors influencing math anxiety
2. Experiences that shape one’s perception of teaching math
3. Strategies and practices that reduce math teaching anxiety
4. Outside influences that effect teachers’ perception

These themes also have sub-themes that further illustrate how math anxiety plays out in a classroom setting. For each theme mentioned above, I will first describe it, then report on the data discovered from interviews, and finally briefly discuss the significance of each theme within the context of the literature described in the previous chapters. Lastly, I summarize my findings and make recommendations for subsequent steps.

4.1 Factors Influencing Math Anxiety

Den and Elisha were the two participants that reported they currently have math anxiety. While Tran reported that she did not have math anxiety or math teaching anxiety, she was able to relay the perspective of other teachers and students who she knows well, and who do possess
math anxiety. In this section, I discuss the negative factors that influence my participants’ math anxiety by exploring their frustration towards teaching math, which is further supported by their physiological response when conveying mathematical concepts in the classroom, as well as their lack of mathematical content knowledge. I first discuss the ways in which my participants portray negative beliefs towards teaching mathematics. Next, I touch on the participants’ experiences that shape their perception of teaching mathematics. Then, I include effective strategies and practices that help reduce math teaching anxiety. Lastly, I discuss the outside influences that effect teachers’ perceptions and provide examples of effective and ineffective professional development opportunities.

4.1.1 Participants’ Frustrations with Teaching Math

While Den and Elisha openly expressed their frustration towards teaching mathematical concepts, they cited that their main issue was the idea of being forced to teach a subject that they could not teach effectively. Throughout Elisha’s interview, she repeatedly said, “There is no option, I should not be teaching math!” While Den, with more than 4 years of math teaching experience, showed some signs of putting in effort and taking the initiative to try to succeed in teaching the mathematical concepts, Elisha, who has 2 years of teaching experience in math, strongly refused to willingly teach the subject. Elisha remarked:

[as] an immigrant coming to Canada 28 years ago, no one told me that as a teacher you might be required to teach math. If someone told me that 28 years ago, I might not have been a teacher at all. I would have reconsidered my career, I swear!

When asked about when they first faced math anxiety or math teaching anxiety, Den and Elisha’s responded, “Since day one!” Den further added, “When you sign up [OT or LTO], it usually says what you are going to be doing and substituting for. And when I see math there,
yeah, it is a little scary!” For Tran, her sister faced math anxiety when she was suddenly required to teach math. Tran noted, “…my sister is … a French teacher. However, she had to teach math one year and was super anxious about it”. Although Tran provided her sister with multiple resources, her sister still felt that she was not successful at teaching math because she said, “‘I'm not good at math, I have never been good at math. I can't do math’… it was a big stress!” Tran realized that her sister was very stressed, but not enough to make her quit. Tran and Elisha’s responses suggest that teaching mathematics is a difficult endeavor which may result in some teachers who experience this anxiety. According to Tran:

They will skim the surface so that they would avoid the student seeing any of their weaknesses which it happens, sometimes. Many teachers don't teach certain strands because of that. [laughs] ‘I don't really know how to do it. So we're just going to skim over that’.

Elisha and Den’s feelings in teaching math aligns with the definitions of math anxiety and math teaching anxiety found in the literature. Math anxiety and math teaching anxiety is defined similarly in that it is a person’s frustration, tension, fear, and scare when encountering mathematical concepts or teaching mathematical concepts, respectively (Boyd et al., 2014; Finlayson, 2014; Gresham, 2007; Liu, 2008; Mutodi & Ngirande, 2014). Peker (2009), for example, defines the absence of math teaching anxiety as the ‘ability’ to teach mathematics without feelings of discomfort when communicating mathematical concepts.

4.1.2 Participants’ Responses to Conveying Mathematical Concepts

Den and Elisha provided examples of their own physiological responses when conveying mathematical concepts in the math classroom while Tran spoke of her students’ physiological
responses. Tran provided a list of physical responses that she noticed in her students. She explained that:

…math anxiety is when someone kind of clams up, they can’t answer a question, their brain kind of just goes into lack of mode and they can’t answer anything regardless of whether or not they know the answer… some kids will show a stutter, some kids you can see it in their face where their eyes start to kind of bulge out, you can see their brow furrows. Also their posture in general… they kind of get into more of a guarded posture… so they will back their chest away, and their shoulders will draw in, they will often look down to the ground, left or right…they will avoid eye contact. When it comes to writing a test, they freeze and panic and might get one question done.

Tran also takes note on how they are answering questions during discussion periods. She believes that students freeze up and speak quietly when their teacher is close to them. When asked a question, they stutter and and start to panic. Therefore, from these findings, it can be said that, for the most part, students feel discomfort during math classes when their teacher are close to them. They may be afraid of doing something incorrectly.

From the perspective of teachers’ math anxiety, Den and Elisha express their psychological response when teaching math concepts from the curriculum. Den, for example, reported:

Like all the time [I feel math anxiety when teaching]! I get stage fright. Especially when it's a very structured, teacher-led like I've got my document camera going or I am using my iPad and I am like you had this last night, you understood it last night… I’m looking at it like yes, I could be reading Chinese right now.

Similarly, Elisha provides another example, “when I am writing on the blackboard and I look back at it and I say to myself I have no idea what I am writing. Consistently checking to see if I
got it right and I could not concentrate.” She feels that these encounters of stage fright and insecurity of teaching math are “paralyzing”. Both Den and Elisha, struggle teaching math, so they have lower levels of mathematics teaching self-efficacy (Bursal & Paznokas, 2006; Lubinski & Otto, 2004). Bursal and Paznokas (2006) and Lubinski and Otto’s (2004), align with what the participants have aforementioned. These teacher and student physiological responses can range from a minor to a major fear of math (Finlayson, 2014) and also accurately represents the definitions of math teaching anxiety and the physical responses that occur in math-anxious individuals that deal with mathematical concepts (Boyd et al., 2014; Finlayson, 2014; Gresham, 2007; Liu, 2008; Mutodi & Ngirande, 2014). As previously discussed, math teaching anxiety triggers feelings and responses of demoralization and uneasiness, which affected these teachers’ ability to teach math. While the focus of the current study is on math teaching anxiety, participants lack of math content knowledge is further analyzed as a possible cause of their math teaching anxiety.

4.1.3 Participants’ Knowledge of Mathematical Content

When asked about what math anxiety means to them, Den and Elisha admitted to their lack of confidence and knowledge in the subject matter. Den noted, “I just don't have as much confidence in my abilities and understanding as I do with other subject areas”. He feels more self-conscious when students address an error that he makes in math class than with any other subjects he teaches. Elisha agreed with Den’s response and added that she feels horrible that she is unable to help the children because she feels that her “knowledge of math is non-existent”. Similarly, Den claimed that he is not equipped to challenge his students because he said, “the things that would appropriately challenge them I wouldn't really understand myself… [so] when we're teaching we're not effective”.

43
Likewise, Tran spoke of a lack of confidence and knowledge as the fundamental reason for why some of her colleagues have math anxiety or math teaching anxiety. Tran noted, “[teachers with math anxiety] will be kind of wishy-washy and sometimes they will try to sell the students on something even though it might not be true [teaching a concept incorrectly].”

The lack of confidence and knowledge in mathematical content translating into math anxiety has been discussed in many studies (Adeyemi, 2015; Hadley & Darward 2011; Finlayson, 2010). The more teachers are exposed to the concepts that must be taught in accordance to the math curriculum of Ontario (Ministry of Education, 2005), the more teachers overcome negative and stressful physiological responses and enhance communication. Furthermore, this relates to larger issues regarding teachers’ lack of confidence and knowledge and how that may potentially transfer to and cause anxiety among their students (Chernoff & Stone, 2014; Liu, 2008; Bekdemir, 2010; Dunkle, 2010; Sloan et al., 2002; Vinson, 2001).

**4.2 Experiences that Influence the Perception of Teaching Mathematics**

This theme centers on participants’ prior and current experiences which shaped their math teaching perception. All three participants spoke of their childhood experiences, which helped form their perception of math. When asked if their math anxiety has been occurring since childhood, Den responded, “I did not continue math after grade 10. When I got that credit, it was done!” Den further noted:

...math didn’t make sense to me…It just didn't, it didn't grab me and what's really scary is the stuff that I was taking in grade 10 we are properly teaching now in grade 8 because it's all been downgraded. So I'm like reliving my nightmare [laughs] of grade 9 & 10 on a daily basis and trying to figure this stuff out.
It is evident through this statement, that Den’s background led to his math anxiety and eventually to math teaching anxiety.

Similarly, Elisha who did her studies in Poland, expressed math as being her weakest subject and only because it was mandatory to take math courses until grade 12 that she proceeded to take them, with great difficulty. Elisha noted “...I was always struggling with it and barely passing because my teachers were kind enough to push me to the next grade.” Although all of Elisha’s teachers were mathematicians and were capable of explaining mathematical concepts well, she felt that “they could not explain anything” to her. Tran spoke of her childhood experiences with math as well, “I grew up in a system of rote learning. So everything we did you would do a hundred questions...I pick up on patterns easily so that’s why I always look for patterns.” Tran further spoke of her experience outside of her schooling. She noted:

One of the reasons why I don't have math anxiety is because I had my first job at age 9. I was managing my own money. I had to collect papers so I had to use multiplying and dividing to make change. I was using math constantly from a young age. I think I just developed more of a strength or I am just more left-brain suited to it….math has always been a part of my life.

Tran’s prior experience of using math in her daily life helped her develop confidence and knowledge in math. Consequently, Den and Elisha’s disinterest, struggle, and lack of knowledge in math classes escalated and has now resulted in their math teaching anxiety.

Den and Elisha’s prior experience is reflected in the literature by Uusimaki and Nason (2004) and Rossnan (2006) as these authors found a correlation between negative beliefs about teaching math and possessing a weak mathematical background and/or having had negative prior schooling experiences. Since Tran does not have math anxiety, her prior experience reflects the
way she feels about teaching mathematical content. Therefore, from these findings, it can be said that, for the most part, a person’s anxiety towards math or teaching math is influenced from their lack of exposure and interest to mathematical content.

4.3 Strategies & Instructional Practices Pertaining to Math Teaching Anxiety

While participants admitted to their experiences of math anxiety and negative encounters when teaching mathematical concepts, they also provided effective strategies and best practices that help reduce their math teaching anxiety or students’ math anxiety.

4.3.1 Effective Lesson Planning Tactics

Tran spoke of tactics that she uses to help her students cope with their anxiety. She reported “I don't address it publicly with the students either and I don't make it obvious in the class for those who have math anxiety by giving all students the right to pass.” All three participants elaborated on the importance of using manipulatives on a regular basis and ensuring that a student’s anxiety does not stand out in the classroom as other students might tease him/her as a result. In this context, Den and Elisha spoke of the value of manipulatives and technology in conveying mathematical content which also helps them with their math teaching anxiety.

Since both Den and Elisha are tackling math anxiety and math teaching anxiety, they explained to me their lesson planning strategies to ease their daily teaching anxiety. When asked how math anxiety affects their teaching, Den replied, “Well I guess I try to perhaps even over-plan at times because you want to be ready for anything and everything.” Den explained that over-planning meant he would type out the “minutia” of everything that he will do and say. His worries arise when he realizes that he is either strayed from his script or if the students ask a question which he is not prepared to answer. Although Elisha admitted to continuously failing
and giving up at preparing an effective math lesson, she agreed with Den that over-planning is a moderately successful strategy for reducing math teaching anxiety.

Den also mentioned the importance of getting to know a student’s skill set and interests. He does this through a diagnostic test to understand students’ skill levels. He found that the most effective lesson planning strategy is to have a “balanced approach” where it is both teacher and student-led. He adds, “I do a balance of group and teacher led. It [has] got to be both. I think you can’t go too far one way or the other.” Having a balanced approach of both teacher and student-led instruction allows for greater growth and for student voices to be equally heard.

Additionally, Den provides another effective lesson planning strategy that helps him with his stage fright. He says it is better to be a transcriber rather than a deliverer and reported:

[the students] were doing some group work, I had them do an open-ended question. And then instead of me having some pre-planned notes where I am going to go through it step-by-step for them and show them the different strategies, I was like, ok, ‘somebody share one strategy that worked for you’. I am going to be the transcriber, let’s go write down step by step what you did to answer the question.

He felt that this allowed for greater discussion and debate but also encouraged multiple learning strategies and approaches as the math work is in students’ words. He emphasized that it “eased his anxiety big time.” He found that implementing these strategies and support systems helped him understand math and in turn, reduced his math teaching anxiety.

These explicit strategies that are reported by the all three participants are present in the literature reviews of Iossi (2007), Bekdemir (2010), Boyd et al. (2014), Bursal & Paznokas (2006), Dunkle (2010), Sloan (2010), Lubinski & Otto (2004), Gresham (2007), Liu (2008), and Vinson (2001). Many effective lesson planning tactics, such as the use of manipulatives, pre-
planned notes, and the integration of a balanced approach are highlighted. The importance of using technology in the classroom to reduce math anxiety is also mentioned in Furner and Duffy’s study (2002).

4.3.2 Lack of Opportunities for Systematic Reflection on Lesson Plans

While successful lesson planning tactics may be used to reduce math anxiety and math teaching anxiety, all three participants spoke of the importance of reflecting on mathematical concepts. The opportunity to repeat a lesson plan and/or mathematical concept allows for reflection, which translates to becoming more comfortable in the math classroom. Den and Elisha’s main issue was the lack of opportunities that they had, to reflect on their lesson plans, as they are homeroom teachers, not rotary teachers. Den noted:

when you teach a lesson and you do ok or it bombs, you have an opportunity to refine it.

Keep refining it. After doing it three times, man then they [students] get it. But in this role [as a core teacher], bomb it, bomb it, bomb it. Because you never have the chance or time to refine it.

According to all three participants, the concept of refining one’s lesson on a daily basis allows for pedagogy development and opportunities to re-teach the concept through a different approach if the first time was not delivered well.

Tran also commented about consistent exposure to mathematical content and language as this can potentially lead to greater abilities in mathematics. She noted, “the more times you see a concept and know where it's going, the better you are going to remember and see that it's relevant or useful.” She further spoke of her example for better preparing students for the following grade. She says:
I introduce them to some concepts for what they're going to see at the grade 8 or grade 9 level and I talk to them about just that. ‘If I show you this now, you are going to see it again next year and you're going to get, ahh, I think Ms. Tran went over that last year’…and then they are in grade 8 and they will realize that they are seeing this for the second time… I give them as much exposure to different things in math as possible.

Furner & Duffy (2002) outlined the myriad of connections between systematic reflection and reassessment of teacher beliefs and emotions towards teaching mathematics. Opportunities of self-reflection are certainly an intervention that show promise to reducing math anxiety (Furner & Duffy, 2002. I was more pleased to find that journaling could be used as a form of communication as well as a tool for self-reflection (Gresham, 2007). It is a task that can be applied in the beginning of the year so that further changes can be implemented throughout the process.

4.3.3 Importance of Creating an Open Communication

While the majority of strategies to reduce math anxiety both in teachers and students were discussed, the three participants also spoke about the importance of having open communication between the student and the teacher. Tran suggested, the best way to reduce anxiety is to communicate with your students by saying, “you know what, I don't know much about this, we're going to learn it together. So let's go on this journey together and discover learning.” Additionally, Tran proposed, “…encouraging them that not all students achieve, go from concrete to abstract math at the same rate” and comforting them that “math anxiety…exists [so] let me know if it's an issue for you so I can try to support you”. She felt that honesty and “mutual openness to learning” are key indicators of being successful in a subject. Similarly, Den reported:
I began the conversation with them...that there is always a teachable moment where we decide, ok people I don't have the answers to everything. I don't understand every strategy... there are only so many strategies that I can absorb, understand, figure out how to teach and deliver it’.

He found that when he has this conversation with his students, he says, “that eases my anxiety and I think that it eases theirs.” He also makes the point about conversing with students about the fact that there is no such thing as a “stupid” or wrong answer. When one stumbles, then they are still encouraged to provide their solution and steps so that the entire class can learn from their error. He says, “…there’s so much learning from the wrong answer.” Both teachers found openly communicating with their students helps reduce math anxiety and encourages students to discover and deliver newer strategies.

Tran and Den’s strategy of communicating with their students is also reflected in the literature review of Iossi (2007) where he mentions that the role of an instructor in the classroom is to encourage mutual respect and psychological safety of students’ math anxiety. Both teachers found that speaking to their students about the topic of math anxiety and the fact that it exists allows for students to not only be well-informed but also takes pressure off of them.

4.3.4 Non-Traditional Approaches Used to Minimize Students’ Math Anxiety

While all three participants provided effective instructional practices, Tran, who does not struggle with math anxiety, gave detailed approaches she uses to help students with their math anxiety. Aside from consistently providing students with feedback on their work, Tran conducts independent sessions where she would meet with students privately and discuss strategies of helping the anxious student overcome his/her insecurity for math.
Another key instructional practice that is addressed by Tran is the concept of teaching about test-taking strategies. She suggests:

Before you look at any question on the test, get out a piece of paper and write down everything you know. For measurement [for example], write down all the formulas you know for area or for volume or for surface area.

This strategy of putting everything down on paper provides students with feelings of comfort and relaxation throughout the testing period. Additionally, Tran uses lots of visual aids and models in the classroom to supplement her speaking. If she needs more student involvement, she uses group work and projects, so that students can work together and ‘piggyback’ off of each others ideas. She suggests incorporating math games into math lessons. She feels:

They're having fun so they don't see the math involved as much…It takes away some of the anxiety. But it's also really important to pair them up with someone of equal skill level so that they're not getting blown away by somebody who is much stronger than them and they are more apt to participate in the game.

She noticed that by implementing math games, students could build their confidence and skill which then transfers to becoming better in the mathematical content.

Many authors address the instructional strategies that are described by Tran (Iossi, 2007; Hembree, 1990; Alkan, 2013). For example, Alkan (2013) discovered that most teachers believed that playing games with their students attracts their interest, supports their learning process of mathematics and in turn, reduces the anxiety. The effects of these non-traditional approaches addressed by Tran are positive on both students and teachers. It is now simply a matter of educating teachers on how to apply these strategies to the five strands of mathematics.

4.4 External Influences Affecting the Teacher’s Perception of Math Anxiety
Here, I elaborate on the external influences that affect my participants’ perception of math anxiety. The external influences I discuss include the school environment and other professional development opportunities. All three participants have differing opinions and experiences of the involvement of their administration and the effectiveness of professional development options.

### 4.4.1 Contrasting Opinions of Administration Intervention

The three participants have contrasting opinions of the involvement of their administration at their schools. Den’s perception of the administration involved in the process of helping teachers reduce their anxiety has not been a satisfying experience thus far. Den spoke of a conversation he had with someone from the administration where he asked them what they have done about such an issue. To which their reply was, “What have you done? So it's not my problem, it is yours. If you are uncomfortable then you figure it out.” Similarly, when Elisha spoke to her administration and made it clear that she cannot teach math effectively, they gave her a math class to teach anyway, without addressing her concerns.

While Den and Elisha may have had disappointing experiences with their administration at their school, Tran noted, “I think right now because the focus for the Ministry is math and numeracy, I think there are a lot of supports out there. A lot of money is being put into the board which the principals have access to supply the teachers with release time to do stuff.” Tran found that if the principal is aware of the issue, they will provide a mentorship with another colleague in the school for guidance and support. Like Den and Elisha, she feels that the administration can still do more, particularly with regards to the students.

Much like the participants, there are contrasting opinions on the involvement of the educational administrators explored in studies (Catlioglu et al., 2014; Hadley, Dorward, 2011). While Catlioglu et al. (2014) spoke for the need of the administration to raise awareness and
educate teachers about math anxiety and ways to support teachers and students, Hadley and Dorward (2011) noted that the administrators do well in providing opportunities for professional development. Through this analysis and my findings, it can be concluded that every administration team is different in their methods of supporting teacher growth and addressing teaching difficulties and thus improvements should be suggested on a case-by-case basis.

4.4.2 Effective Professional Development Opportunities

Tran provided examples of effective professional development opportunities that are available for teachers to attend, aimed at reducing their math stress and helping them become comfortable dealing with and teaching mathematical concepts. She says that they usually get “release time to go to math conferences and workshops, we bring in resource teacher from the board…, math PD… [and]... TIPS for M, which is the targeted implementation planning support modules, which is resources developed for math.” Specifically, these resources help teach educators mathematical concepts in various ways to better their own understanding. She notes that another way to engage students is via a “math website which has multiple entry points especially for students who are struggling with math…There is also leaps and bounds… it is Marian Small and differentiated instruction by Marian Small.” These were resources that were available for all teachers during Professional Development meetings for greater awareness. She expresses that the Marian Small provides multiple entry points for various students at different grade and skill level. Also, it provided students with an evaluation at each level and gives the teacher strategies, entry points on how to support students with their struggle. For students, Tran also suggests attending the Ontario Focused Intervention Partnership tutoring program (OFIP). OFIP is an opportunity for grade 6 students to receive support on any math homework from teachers who are funded by the school board.
While Tran provided effective resources, Den argues that although he has a lot of manipulatives in his classroom, he does not know how to use them. He stated:

I don’t know how to use 90% of that stuff. So how about some stations where there are expert groups and people who really knows their stuff [do]a mini-lesson for a small group of teachers and does a little tiny workshop on just how to use these.

He suggests that they can be experts from outside the school or experienced staff members that know how to use the materials. Becoming more comfortable and knowing how to use the manipulatives and available resources is necessary for teachers, and is an issue that must be addressed so that teachers can effectively use these resources to help their students.

Den’s suggestion of becoming more familiarized with manipulatives, aligns with Gresham et al. (1997) and Vinson’s (2001) findings. Vinson (2001) studied the use of manipulatives as an effective method for alleviating math anxiety in teachers. The researchers placed emphasis on learning mathematical content by use of manipulatives as a tool to better understand mathematical concepts. Throughout his paper, he argues that focusing on the process of teaching for understanding rather than procedure can help reduce both teacher and student anxiety. Den’s suggestion of becoming educated on the proper use of manipulatives is accurate, as he realized that the use of manipulatives do help make concepts a lot more concrete and meaningful to students (Gresham et al., 1997; Finlayson, 2014). This is one strategy any administration department can certainly implement in helping their teachers further develop their skills.

4.4.3 Ineffective Professional Development Opportunities

Both Den and Elisha believe that if someone is not comfortable in teaching a subject, then they should not be forced to teach it. Elisha describes this structure, of forcing a teacher to teach a subject they are not fully comfortable with, as an ineffective professional development
opportunity. She noted, “They have to be strong and confident and know how to handle kids’ questions and how to come up with interesting ideas and lesson plans. For [Den and I], it is just a struggle.” She found that when she tried to increase her confidence in her ability to teach the mathematical concepts through workshops and conferences, they were not effective for her. She believes sending her to a workshop or a conference will not help her in her math teaching anxiety. Although she did not specify the name of the workshop, her experience at one place in particular, left her saying, “I still don’t know how to teach math; [they] didn’t help me with anything.” Elisha found that various attempts in trying to become an effective math teacher was just not working for her. Her struggle to discover an effective professional development opportunity caused her to give up.

The struggles of teaching core subjects as described by Den and Elisha are reflected in the results of the study by Hadley and Dorward (2011). Hadley and Dorward (2011) believe that the administrators should assign the grade levels that the teachers are most comfortable teaching. When teachers are forced to teach grade levels that they cannot teach, they decide to give up like Elisha did, and as a result, the students are negatively affected.

4.5 Conclusion

Four themes emerged and were examined in greater detail in this section. The first two themes focused on recognizing the issue of math anxiety and/or math teaching anxiety, while the second two themes concentrated on ways to reduce math anxiety and/or math teaching anxiety.

All participants provided an idea of what math anxiety looks and feels like. The most important factor influencing math anxiety is the negative emotional and physical responses that educators have for teaching mathematical concepts. This is supported by their evident frustration and physiological responses of fear and nervousness when attempting to deliver concepts in the
math classroom. Much of the articles that define math anxiety and math teaching anxiety provide similar reactions of what three participants in this study expressed. Furthermore, many articles have been written about learners’ emotions and frustration when dealing with mathematical concepts. However, more work needs to be done on in-service teachers’ feelings towards teaching math.

Secondly, teachers’ prior experiences and lack of exposure to mathematical content affected their position on teaching mathematics. Exposure to mathematical concepts outside of the school and home was what really helped Tran in not being math-anxious. As for Den and Elisha, although they had effective teacher experiences, and effective coping mechanisms for their anxiety, there was a lack of interest and involvement in learning math at a young age which may have translated to their anxiety in teaching math in their careers.

Next, I found that teachers provided excellent strategies and teaching practices to help reduce math teaching anxiety. Whether integrating the effective strategies into their lesson plans or providing instructional practices during class time, the participants found these methods to be helpful for both students and teachers. Den and Elisha found that there is a lack of time and opportunity to reflect on their lessons as there is only one class of math that they teach. While these teachers may not enjoy teaching math, they feel that by repeating their lessons, they are less prone to making mistakes and errors in their teaching. Additionally, for all participants, creating an inclusive community for open communication is highly important. They encourage teachers to take the time to speak to their students about accepting mistakes and learning from them. These positive benefits make the case for why teachers should begin the school year with discussion and by educating their students about math anxiety.
Finally, I found that there were contrasting opinions about the external influences that may be affecting teachers. From their own experiences, Den, Elisha, and Tran found that although some administrations help teachers reduce their anxiety, there are still schools where no effort is implemented, and this in turn, deepens the gravity of the anxiety faced by students and teachers. Elisha spoke about the ineffectiveness of some of the workshops she attended while Tran provides examples her experiences with some exceptional stress-busting workshops. In this context, I was surprised to see limited literature available regarding the effectiveness of the professional development opportunities that Tran mentioned. Thus, it is worth conducting further research in this area to determine the true effects of external resources and influences on teacher attitudes towards mathematics.

Each of the three participants that I interviewed for this study have delivered suggestions and ideas that other math anxious teachers can implement in their teaching curriculum. Since math anxiety is susceptible to being passed from teacher to student, going forward more research needs to be done on the willingness to explore various avenues, by teachers, to improve their knowledge and confidence in teaching mathematics. Next in Chapter 5, I discuss broad and narrow implications for the findings I have analyzed, give recommendations and provide potential areas of further research.
Chapter 5: Research Implications

5.0 Introduction to the Chapter

This study was created for the purpose of studying how three middle school math teachers perceive the impact of their math teaching anxiety on their students. It also compared the study findings to the literature available in the field in order to explore effective strategies that will reduce math anxiety for both learners and educators.

In this final chapter, I present the research implications of the findings in Chapter 4. The findings were analysed and organized by themes and sub-themes. Further analysis and a description of the findings are presented in this section. More specifically, an explanation of the broad and narrow implications of the issue of math anxiety will also be discussed. Next, the chapter will report limitations and recommendations for next steps and how to enhance the structure of the study. Finally, this study will conclude by presenting areas of further study and final concluding statements.

5.1 Overview of Key Findings and their Significance

Mathematics is a core subject that is taught in every grade in both elementary and high schools. It is viewed as an important subject that is integrated not only into school curriculums, but also into our daily lives and in the workforce. While math is a subject taught in schools, for many people, it is also a subject that creates some insecurities and lack of good understanding. Effective pedagogical practices are important for math to avoid feelings of anxiety and insecurity.

Specifically, my research study focused on discovering each participants’ definition of math anxiety, how they believe their anxiety affects student math performance, effective classroom strategies they use to help with student and teacher math anxiety, and the quality of
available institutional/administrative support. The findings from teachers’ interviews suggest that promoting group work, using a student-centered approach, use of technology and manipulatives to engage students, and creating an open dialogue with students about math anxiety are a few effective ways to cope with math anxiety.

Throughout the course of the study, four main themes emerged in addressing the main research question. They are: factors influencing math anxiety, experiences that shape one’s perception of teaching math, strategies and practices that reduce math teaching anxiety, and external influences that affect teacher perceptions of mathematics. An overview of key findings and their significance are as followed.

Math anxiety is a complex and reoccurring issue that can affect both teachers and students through different experiences. A consequence of math teaching anxiety is the negative result of the anxiety to potentially be transmitted to students which affects student performance and competency in math. Participants discussed how math anxiety is when students lack confidence in their ability to do mathematical concepts. A math-anxious individual usually feels they cannot answer anything and often feels less confident in dealing with mathematical concepts.

Major findings of this study included participants’ definitions of math anxiety, effective strategies in reducing math teaching anxiety in the classroom, and professional development support that is available for math anxious teachers. The teachers started by describing their perception of math anxiety. Next, they provided strategies that they felt were effective in addressing their anxiety whether for themselves during their teaching time, or for their anxious students. Finally, the participants described professional development opportunities that are available for them in their school. The meaning of these findings addressed in the next section are a result of the research question.
First, defining math anxiety was crucial in order to understand how teachers understand the concept. The participants provided a descriptive definition of math anxiety, and each definition was consistent with that of the literature (Boyd et al., 2014; Finlayson, 2014; Liu, 2008; Mutodi & Ngirande, 2014; Peker 2009). For the literature to align with the definitions that were noted by the participants is very important because it means the topic of math anxiety is addressed in schools today. It also means that this is an issue that teachers are aware of but may possibly not know how to overcome. For example, all three teachers described a math-anxious individual as someone who does not have much confidence and understanding in the mathematical concepts, noting specific characteristics and facial expressions of their students who face math anxiety. In addition to providing the definition of math anxiety, participants also elaborated on potential causes and effects of this anxiety in their students and in themselves. Some of the causes that were mentioned by the participants are family influences, prior negative experiences, lack of support, lack of understanding the mathematical concepts, and low self-confidence.

The second part of the study looked at effective strategies in reducing math anxiety in the classroom. All participants felt that by allowing students to be involved with the process of solving a problem, they are encouraging students to take risks, learn from each others’ strategies, gain confidence, and reflect on their own work. Additionally, group work and preparing well ahead of class time decreases feelings of tension.

Finally, the last part of the study looked into available institutional practices and support for math anxious teachers. All three participants had differing views about the degree of support that they were receiving from their administrative staff members. They did note, however, that many schools are providing workshop opportunities for their teachers to attend but that schools
could do more to support the teachers, as workshop training is only one resource, and may not be beneficial for every teacher.

5.2 Implications

The results of this study contain implications for the broader community of educators and students, for it identifies ways to address student needs both emotionally and physically, develop math positivity in students, and support students’ academic careers. In addition, the implications of this study also include professional identity and practice and teacher pedagogy to successfully cope with math anxiety.

5.2.1 Implications for the Educational Research Community

Results of this study portray that problems of math anxiety are related to feelings of insecurity and shyness of producing wrong answers. Therefore, an implication for the educational research community would be to encourage schools to take action plans around allowing staffs to take risks and reflect on mistakes. Risk-taking may amount to lessen the errors for future teachings. In addition, encouraging students to take risks and learn from their own mistakes may increase confidence in their ability to do math. Therefore, when the schools can, they may provide various examples of action plans to address mistakes. Establishing a school based on positivity, acceptance of educators answers and approaches, and reflecting on the reasons behind incorrect answers may be a few steps towards remedying some of the issues that came to light from educators in this study.

Some participants in this study claim that the professional development opportunities were ineffective and did not change their views about mathematics. Another implication for the educational research community is to determine ways to meet the needs of educators through these professional developments. Professional development sessions allow for personal growth
as an educator and also provides improvements for pedagogical practices. However, if educators’ needs are not met, then they may become disengaged and feel frustrated, as some of the participants shared.

5.2.2 Implications for Professional Identity and Practice

The conclusion drawn from this study offer effective practices for educators alleviating their math anxiety. Participants from this study portray, in detail, their beliefs that parental influence can be a causal factor of math anxiety in students. As a result, an implication for professional identity and practice is to encourage students’ parents and/or guardians in the process of their child’s learning. Educators can support students’ emotional and social wellness by continuously providing the parents feedback, which will in turn encourage students to either continue to do well or be motivated to do even better. Involving parents and/or guardians in the process of students’ education creates awareness of students’ situations and allows for parent and/or guardian to find ways for improvement and growth. Therefore, this does highlight the need for everyone to communicate well.

Lastly, the results of this study have specific implications for myself as an educator. The interviews conducted for this study have brought forth the various strategies teachers apply to cope with their anxiety for mathematics. As a new educator, I plan to effectively implement manipulatives and games in the classroom. The value of manipulatives was repeatedly mentioned by my participants and was also repeatedly reported in the literature (Iossi, 2007, Vinson, 2001). In order to implement this strategy myself, I plan to take workshops and courses about manipulatives and classroom games. Not only would the use of technology ease student anxiety, but it will also introduce new learning approaches that may be helpful for those students who are visual and hands-on learners. Even for myself, as a graduate student of Mathematics for
Education, I believe by applying math activities with manipulatives and games in the classroom, it can enhance my learning and understanding of alternative approaches to certain mathematical concepts. Therefore, in moving forward with my career, I will apply the strategies suggested by my participants to my own practice in hopes to create change and awareness for the issue of math anxiety. I will ensure that I am aware of my students’ needs and fundamental skills so that I may help each student accordingly. I will further ensure I maintain an open line of communication with my classes and that I speak with them about this fundamental issue and their perspectives on it. I must comfort them into feeling confident in their inherent abilities as well as their potential to improve their skills in mathematics and in every school subject. In addition, I plan on being a mentor, a resource and a working-partner in the school where staff members can come for support

5.3 Recommendations

Several recommendations have been discovered and suggested through the implications of this research study for both new and existing teachers experiencing math anxiety. It is recommended that teachers seek help from the school administration and/or colleagues for resources and/or professional development opportunities to successfully teach mathematics. In order to apply new learning styles, teachers should be supported in developing the skills to effectively use manipulatives in accordance with the math curriculum. Additionally, creating a positive and welcoming classroom environment is a recommendation that I have come to, as a result of my findings. When teachers apply these strategies, they encourage the classroom atmosphere to be a positive, comforting, and collaborative. In order to support students’ well-being, teachers should continually have positive conversations about math anxiety with their students. This can be comforting for both the educator and the student. Lastly, in order for
teachers to learn from their mistakes, improve, and reduce anxiety, it is important for them to regularly reflect on their own practices.

5.4 Areas for Further Research

This study portrays that the acquisition of various effective teaching strategies to reduce teacher anxiety may result in reducing student anxiety. Although this research project was successful at addressing this issue, there still remains several questions that require further investigation. Future research can look at after school programs that are available to better understand how to treat the math anxiety present in students and teachers. Specially, looking at the after school program called Counting on You, which carry an intention to provide additional support and practice for students that need help in reading, writing, and math (Peel District School Board). Also looking at thinkMATH@home, which is directed to helping children love and learn mathematics through solving real-life problems from their homes (Toronto Catholic District School Board). Perhaps the findings when comparing the two different programs, can create some discussion. It raises further questions such as, does the facilitation of the after school and at home program, Counting on You and thinkMATH@home, help reduce math anxiety that some students may have. What factors influence math-anxious students’ decision to participate or not participate in the Counting on You and thinkMATH@home program? Another program to investigate would be the Ontario Focused Intervention Partnership tutoring program (OFIP) that is mentioned by one of my participant. According to the participant, OFIP is an opportunity for grade 6 students to receive support on any math homework, so analyzing the effectiveness of this program to students’ mathematical competence is another area for research.

Similarly, the effectiveness of manipulatives in reducing math anxiety over a long period of time is worth investigating as well. Furthermore, exploring play-based approaches in
mathematics would be helpful for educators both in the context of addressing their anxiety and also their students’ anxiety. Finally, participants provided mixed feelings with regards to the involvement of their school administration in addressing math anxiety. So, exploring teacher and administration relationship is another area of study that can be further researched.

5.5 Concluding Comments

Math anxiety is a major issue that needs to be addressed. Committing to combating math anxiety and discovering effective strategies to help students will improve student learning, and possibly produce students who enjoy math. Therefore, it important for both teachers and administrators to take the time and effort in providing effective resources and exploring the topic of math anxiety in their schools. Action plans need to be implemented in ensuring that all students feel comfortable conveying their mathematical knowledge in the classroom.
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Appendix A: Letter of Consent for Interview

Date:

Dear ______________________________,

My Name is Nilab Sidiqi and I am a student in the Master of Teaching program at the Ontario Institute for Studies in Education at the University of Toronto (OISE/UT). A component of this degree program involves conducting a small-scale qualitative research study. My research will focus on mathematics anxiety in early teaching elementary teachers and how are they coping with their anxiety. I am interested in interviewing teachers who have or had mathematics anxiety. I think that your knowledge and experience will provide insights into this topic.

Your participation in this research will involve one 45-60 minute interview, which will be transcribed and audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient for you, outside of school time. The contents of this interview will be used for my research project, which will include a final paper, as well as informal presentations to my classmates. I may also present my research findings via conference presentations and/or through publication. You will be assigned a pseudonym to maintain your anonymity and I will not use your name or any other content that might identify you in my written work, oral presentations, or publications.

This information will remain confidential. Any information that identifies your school or students will also be excluded. The interview data will be stored on my password-protected laptop and the only person who will have access to the research data will be my course instructor. You are free to change your mind about your participation at any time, and to withdraw even after you have consented to participate. You may also choose to decline to answer any specific question during the interview. I will destroy the audio recording after the paper has been presented and/or published, which may take up to a maximum of five years after the data has been collected. There are no known risks to participation, and I will share a copy of the transcript with you shortly after the interview to ensure accuracy.

Please sign this consent form, if you agree to be interviewed. The second copy is for your records. I am very grateful for your participation.

Sincerely,

Nilab Sidiqi
Email: nilab.sidiqi@mail.utoronto.ca

Instructor’s Name: Dr. Rose Fine Meyer
Email: rose.fine.meyer@utoronto.ca


**Consent Form**

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw from this research study at any time without penalty. 
I have read the letter provided to me by Nilab Sidiqi and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ________________________________

Name: (printed) ________________________________

Date: ________________________________
Appendix B: Interview Protocol

Thank you for agreeing to participate in this research study, and for making time to be interviewed today. This research study aims to learn how teachers with math anxiety cope with their insecurities for mathematics for the purpose of helping those who are fighting with the same problem. This interview will last approximately 45-60 minutes, and I will ask you a series of questions, beginning with the participant’s background information, followed by questions about their encounter with math anxiety as a teacher, then their experiences and strategies related to coping with their math anxiety.

I want to remind you that you may refrain from answering any question, and you have the right to withdraw your participation from the study at any time. As I explained in the consent letter, this interview will be audio-recorded. Do you have any questions before we begin?

To begin can you state your name for the recording?

Section A - Background Information

1. How many years have you been working as a teacher in Canada?
2. For how long have you been teaching mathematics?
3. Do you or have you faced math anxiety at any point in your teaching?
4. What math grades have you taught before?

Section B - Teacher Perspectives/Beliefs

1. What does math anxiety mean to you?
2. How does math anxiety affect you’re teaching?
3. Are your students math anxious?
4. In your view, what kinds of attitudes and behaviors are indicators of math anxiety?
5. How long have you been math anxious? (If more than 3 years- Why haven’t you done anything about it?)
6. Does your math anxiety come from your childhood? Tell me about your experiences as a student in the Canadian public school system. Do you think that your previous teachers were also fighting against math anxiety?
7. What made you think that you have math anxiety?

Section C - Teacher Practices

1. Is this a prevalent topic among your colleagues? Are other teachers doing best to stay away from teaching mathematics? If yes, why do you think it is?
2. If you recognize math anxiety in your students do you address it? If yes, how?
3. What strategies, instructional practices do you use to avoid any symptom of math anxiety?
4. Give an example of a time when you noticed your anxiety while teaching.
5. What has the department head or principal in the school done to help any colleague overcome their math anxiety?
6. Are there any memorable (positive or negative) experiences from when you were a student in your mathematics class that influences your teaching?

Section D – Supports, Challenges, and Next Steps

1. Do you feel that the school is doing everything they can to help reduce math anxiety? If yes, what are they providing?
2. What kinds of resources do you feel helpful for reducing math anxiety within teachers?
   Within students?
3. Have you reached out to any mathematics programs and thought that this might help me alleviate my anxiety? If not, why not? If yes, what do you think about the supports that were available?

Next Steps

1. What advice do you have for beginning teachers that may also want to alleviate their math anxiety?
2. Do you think it is ok for a student to openly admit and tell their teacher that they are facing anxious when in math class?

Thank you for your participation in this research study.