How do teachers instructionally respond to students’ experience of math anxiety?

by

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A Major Research Project submitted in conformity with the requirements for the degree of Master of Teaching

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Abstract

This research project investigated how teachers instructionally respond to students’ experience of math anxiety. The existence of math anxiety is pertinent in and out of our education system, and it is crucial to deconstruct math anxiety for what it is. This project aims to identify the various factors that contribute to math anxiety, the role of gender in math anxiety, how different stakeholders in a student’s life impact their experience of math anxiety, and specific teaching strategies that can prevent and reduce math anxiety from interfering with student learning in the classroom. Along with an extensive review of the literature, 2 math educators were interviewed in this research project in order to gain further insight on math anxiety in the classroom. Math anxiety perpetuates in adult life and can have serious implications if it is not addressed within the education system.

Keywords

Math anxiety, gender, teachers,
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Chapter 1: Introduction

1.0 Research Context and Problem

Math is commonly regarded near the top of the school subject discipline hierarchy, as evidenced by the disproportional instructional time it is allotted in school curricula and by the amount of resources invested in evaluating student math achievement in the international arena. Nevertheless, students’ experience of anxiety in math is more common than in other subjects (Blazer, 2011). The flaw in this model is that even though math is deemed important, it is often too anxiety provoking for students to succeed in it. Math anxiety is a common phenomenon in many education systems and tends to begin around fourth grade and peak at middle and high school (Blazer, 2011). Math anxiety is defined as negative emotions that interfere with the solving of mathematical problems (Blazer, 2011). Due to its ability to interfere with problem solving, math anxiety can have serious implications for student achievement in math.

In Ontario, students’ math achievement is measured by a standardized test administered from the Educational Quality and Accountability Office (EQAO). Additionally, EQAO conducts research on math achievement and found that a strong and persistent relationship exists among math achievement, student attitude toward math and student confidence in their ability to do well at math (Pang & Rogers, 2013). These findings target some success criteria for math achievement, but research shows that math achievement is declining. Since 2006, math scores in Ontario have been consistently dropping and there is reason to believe that students’ math achievement decreases as they get older (MacDonald, 2014). One study, for example, tracked cohorts from 2006 to 2012 and found that 18% of students met the math standard in Grade 3 but
did not in Grade 6 (MacDonald, 2014). This may be due to a variety of factors, but math anxiety is an integral part of this problem.

Negative emotions related to math also deter students from situations in the future that may involve math such as future math classes (Blazer, 2011). Math anxiety exists on a spectrum and for some students can be described as “the panic, helplessness, paralysis and mental disorganization that arises…when they are required to solve a mathematics problem” (Tobias & Weissbrod, 1980, p.65). The seriousness of math anxiety can lead to preventing students from achieving successful performance and achievement goals in education. There is a strong negative correlation between math anxiety and math test scores. As math anxiety increases, test scores decrease (Blazer, 2011). Success in math often influences a student’s confidence in overall academics which relates to self-esteem. Ironically, research has shown that people’s anxiety in math, and not their actual math ability, is the greatest obstruction to math achievement (Maloney & Beilock, 2012). Consequently, math anxiety is troubling because it could be the cause of low math achievement, while many students may continue to believe their lack of success is due to their incompetence.

Gender differences tend to emerge in math anxiety as research shows that math anxiety is more prevalent in girls (Hembree, 1990) and this could also contribute to the gender differences that exist in different careers. Math anxiety continues to be a prevalent problem even in higher education and is problematic due to the need for a workforce in Science, Technology, Engineering and Mathematics (STEM) fields (Nunez-Pena, Suarez-Pellacioni, Bono, 2013). Although in recent years women are earning more degrees in STEM fields, they remain underrepresented in the STEM academic faculty (Stevenson, Glass, Minnotte, 2010). Math anxiety may contribute to these facts as it perpetuates in higher education and could have
implications for students in their future careers. Students who perform poorly in math continue to suffer beyond the classroom because success in math is held at a high standard in society throughout life.

Math anxiety does not solely exist within students. Math anxiety within teachers directly affects math learning for students (Maloney & Beilock, 2012). This trend perpetuates the cycle of math anxiety from generation to generation. Disheartening results of a study showed that math anxious female teachers who endorsed the common stereotype that “boys are good at math, girls are good at reading” often produced female students who consequently also endorsed this stereotype (Maloney & Beilock, 2012). The researchers found that these female students were then behind in math at the end of the school year but the boys were not. As aforementioned, math anxiety is more prevalent in girls and women are underrepresented in STEM fields and careers. Additionally, they found that girls are more prone to worsened math performance when being taught by a math anxious teacher. Math anxiety is a perpetuating cycle layered with complexity and it is crucial for educators to combat it in their classroom to stop this trend.

It is essential that educators begin advocating for teaching practices that combat math anxiety due to its detrimental effects on students. Blazer (2011) contributes an extensive list of strategies teachers and parents can use to combat math anxiety. This list includes strategies such as developing strong math skills and a positive attitude about math, not using math as a punishment, relating math to real life, using technology, providing differentiated teaching methods, using manipulatives and providing a variety of assessments. This list includes many more strategies but these are some of best teaching practices that have been found to combat math anxiety. The research supports that similar strategies are useful in post-secondary education through the use of portfolios, journal writing, teaching critical thinking and using performance
tasks (Woodard, 2004). Creating a non-threatening atmosphere where students feel comfortable giving oral answers, facilitating cooperative groups helps students relate to others with similar struggles as them, providing an opportunity to retake tests and being available as a tutor have all been found as strategies that reduce math anxiety and increase success in math for students. (Woodard, 2004). These teaching strategies can seem overwhelming to implement in a classroom, but with perseverance and dedication, they can make a big difference to students in their math learning experience.

1.1 Purpose of the Study

In lieu of the apparent problem of math anxiety, the goal of my research is to learn what teaching practices are the most beneficial to instructionally respond to a student’s experience of math anxiety. Additionally, I want to know how the cycle of math anxiety continues to perpetuate despite the ample amount of research done in the field. Math is difficult to grasp for many learners and a part of improving is making mistakes along the way. I intend to research teaching pedagogies that aim to alleviate math anxiety in students, focusing on how teachers can create a math positive class. Math anxiety can prevent students from understanding the normativity of mistakes in math and therefore can stand as a barrier to resiliency. Teachers can play an active role in empowering student with math anxiety by using more effective language when framing a testing situation as a challenge and not a threat (Maloney & Beilock, 2011). These seemingly minimal strategies could have the potential to instill a love for learning in math. A love for learning and resiliency in math can carry these students towards success beyond the classroom, and positively influence their success in other subjects as well.
1.2 Research Questions

In my research, I want to focus on how teachers instructionally respond to students’ experience of math anxiety. More specifically, I want to investigate how teachers create a math positive class and the relationship it has to math anxiety.

Subsidiary questions include:

What experiences influenced these teachers commitment to combatting students’ experience of math anxiety? How do teachers think math anxiety effects boys and girls? What role do teachers think parents, peers and social norms play in a student’s experience of math anxiety? How does the gender of the math teacher influence a student’s experience of math anxiety it the classroom? These are some of the key questions that I will be asking in my interviews with current educators because they will lay the foundation for my research.

1.3 Background of the Researcher

As someone who for nearly all my schooling felt like a student that was labelled at being “good at math”, it is difficult for me to completely understand math anxiety because I may not have experienced it to its fullest. Although I experienced one bout of math anxiety in my final year of high school, I managed to overcome it and continued studying math in post-secondary education. When I experienced math anxiety, my confidence and perceived math competence were debilitated, but due to my prior positive experiences with math, I persevered. Simple stated, my math anxiety never detrimentally affected my performance or achievement goals as it does for students that suffer with more chronic math anxiety.

I also had the privilege of growing up in a house hold that was very math positive. My dad loved math and I never witnessed math anxious parents growing up. Additionally, I had the
privilege of having good math teachers. I cannot remember a time where I did not have a math teacher that resonated with me, and this helped build my foundation in math. I developed resiliency because I had teachers who were competent, supportive and challenged their students to succeed.

Research has shown that math anxiety is often rooted from environmental factors such as over demanding parents and unhealthy classroom environments. Repeatedly, it has been shown that “math teachers who are unable to adequately explain concepts, lack patience with students, make intimidating comments, and/or have little enthusiasm for the subject matter frequently produce math-anxious students” (Blazer, 2011, p.2). I am privileged to have had healthy math environments at home and in the classroom and this has greatly benefitted my attitude and success toward math. With minimal personal experiences of math anxiety, I want to conduct research on this topic because I do not want to take for granted that since it came relatively easy to me, it will be the same for all students. The more informed we are about math anxiety, the more we can empathize with our students and be able to instructionally respond to their experiences of math anxiety.

1.4 Overview

In order to make meaning to the research questions that I have posed, I will be conducting a qualitative research study by interviewing 2 educators about their teaching practices regarding math anxiety and what they feel are key components in creating a math positive climate in their classroom. I will be inquiring about specific pedagogical tools that these educators use to instructionally respond to students’ experience of math anxiety in the classroom. I will also be keen on discovering what factors contributed to the educator’s commitment to responding to students with math anxiety. In Chapter 2, I will review the vast research and
literature on the areas of math anxiety. This will range from the antecedents of math anxiety to the strategies that effectively combat math anxiety. In Chapter 3 I will elaborate on the research design of my qualitative study. In Chapter 4 I will summarize my research findings from the interviews and in Chapter 5 I will elaborate on the relationship between the findings and the current literature. I will also discuss the implications for my own teaching practice and determine what is needed in order to create a math positive climate in the classroom in hopes to eventually defeat math anxiety within students.
Chapter 2: Literature Review

2.0 Introduction

In this chapter I review the literature in the areas of math anxiety and how educators instructionally respond to students’ experience of math anxiety in the classroom. I review the literature regarding the definition of math anxiety and its detrimental effects on students in the classroom. In order to better understand how math anxiety is experienced by different students, I review some research that has been done on gender differences in math anxiety. Additionally, I review the future implications of math anxiety and how it is a pervasive issue especially for women in their adolescent and adult lives. I also review the relationship between math anxiety and math performance, and the mediating factors of this correlation. Finally, I will review strategies teachers can use to instructionally respond to students’ experience of math anxiety and the importance of creating a math positive classroom.

2.1 Definition and Development of Math Anxiety

Defining Math Anxiety

Research on math anxiety often encompasses different layers of potential causes and consequences. Definitions on math anxiety vary minutely, and it is broadly described as a feeling of tension, apprehension, and fear of situations involving math (Beilock & Willingham, 2014). A more provocative definition by Stuart (2000) refers to math anxiety as a feeling of “sudden death”. Additionally, students with math anxiety often feel like everyone around them knows they do not understand the math problem. This frame of mind debilitates them mentally and may restrict them from asking questions due to fear of looking incompetent. Math anxiety is prevalent
in and out of classrooms, with approximately 93 percent of Americans indicating that they experience some level of math anxiety (Blazer, 2011). Due to the overwhelming amount of math anxiety experienced, it is crucial for teachers to address it in the classroom where it is induced regularly. In order for teachers to effectively combat it, they must first fully understand the depth of the condition.

What causes math anxiety?

The causes of math anxiety can vary from student to student. Research has shown that similar to test anxiety, math anxiety seems to be a learned condition that is more behavioural in nature than cognitive (Hembree, 1990). On the surface, it is difficult to identify all students with math anxiety because it manifests in different ways. Although math anxiety appears to manifest behaviourally, Beilock & Willingham (2014) conducted a study that provided reason to believe that math anxiety does have a cognitive basis. The researchers claim that math anxiety robs people of valuable working memory. This is significant because working memory is required in order to keep choices in mind and think about consequences for those choices. Working memory is essential for solving problems, and when students have math anxiety they cannot use their working memory efficiently (Beilock & Willingham, 2014). Clearly, there is not one singular cause of math anxiety, but it is essential to know possible causes so educators can combat it appropriately in their classrooms.

Math anxiety is rooted in multiple causes and can effect students differently. There are also social influences that contribute to math anxiety. Students are primarily influenced by parents and teachers for a large portion of their lives. When these influential adults have math anxiety or negative attitudes towards math, students often begin to internalize the same values.
Research has found that biological and social influences can build into math fears later on and math anxiety can become a generational problem, since adults that are uncomfortable with math pass negative feelings on to their children or students (Sparks, 2011). This contributes to the perpetuating cycle of math anxiety and why it continues to infiltrate into education despite an increasing amount of math resources for teachers. Since math anxiety is correlated with lower math performance, students attribute their failure to math incompetence (Sparks, 2011). This could have manifested due to social influences, but students perceive their failure as their own fault. This attribution could spiral into beliefs about academic success, self-esteem and could lead to math avoidance behaviours later on in life.

Teachers are an inevitable primary social influence for students. Students’ experience of math anxiety can often be influenced by their teacher’s attitude toward math (Beilock et. al, 2010). A study looked at female teachers’ math anxiety and how it affects girls’ math achievement. It is common for elementary school teachers to be anxious about math, and when they have to teach math to students it can have detrimental consequences on student achievement (Beilock et al., 2010). In the U.S.A, more than 90% of elementary teachers are female. Children are more likely to emulate behaviours and attitudes from same-sex adults and this may be why girls perceive math anxiety in their female teachers more than boys (Beilock et al., 2010). The study found that by the end of the school year, the higher the female teacher’s math anxiety, the lower the girls’ math achievement. Boys’ math achievement was not affected by the female math teacher’s anxiety in this study. Additionally, girls who had traditional gender ability beliefs about which gender is good at math and which gender is bad at math, also had lower math achievement (Beilock et al., 2010). This achievement gap is problematic because it is primarily issued by
students’ socialization. Whether educators realize it or not, they contribute to the perpetuation of math anxiety within students.

Teachers also have potential to be active agents in creating a positive math experience for students to help reduce math anxiety. Teachers can reduce some stigma associated with math such as math aptitude being genetic and math being a male domain (Woodard, 2004). In order to better the math experience in classrooms, teachers can be more flexible with grading math tests, explore unique assessment techniques such as observation and demonstrations and exhibit enthusiasm about the subject (Woodard, 2004). Positive attitudes towards mathematics is consistently related to lower math anxiety. Lower math anxiety can lead to enjoyment of the subject, self-efficacy and higher math achievement (Hembree, 1990). Teachers and parents are a primary social influence for students and play a crucial role in a child’s development academically. It has been shown that teachers can both have a positive and negative influence on students’ experience of math anxiety in the classroom. In order to have a positive influence on students’ experiences of math anxiety, it is crucial to recognize some of the causes of math anxiety such as poor instruction, negative attitudes about math, negative math experiences and low self-esteem (Woodard, 2004). Once teachers are more educated on the causes of math anxiety, they can begin practicing effective teaching pedagogy to combat math anxiety in the classroom.

Due to the severity of math anxiety, some students might refrain from asking questions when they feel math anxious. On the contrary, others might try and appear apathetic to math in order to protect their ego. The onset of math anxiety generally occurs in elementary schools where students are entering the complexity of early adolescence (Hembree, 1990). These
behaviours may not singularly indicate math anxiety, but should alert teachers to the possibility of a student being math anxious. Math anxiety may emerge earlier than adolescence as a study reported math anxiety in students as early as Grade 2 and unfortunately, higher math anxiety was associated with lower achievement (Beilock & Willingham, 2014). More commonly, math anxiety seems prominent in students from Grade 6 to post-secondary school. Math anxiety increases for both genders around junior high, and peaks near Grade 9-10 and plateaus in upper high school. (Hembree, 1990). Math anxiety may also peak at Gr 9-10 because this tends to be around when math content peaks in difficulty. Students’ experience of math is also influenced by how math is portrayed in the media (Mendick, 2005) and exposure to various media outlets also increases during adolescence. Social influence is not limited to the media and teachers since students’ math anxiety experiences can also be affected by society values, peers and parents. These outputs can impact a student’s experience of math anxiety in and out of the classroom.

2.2 Math Anxiety and Math Performance

Correlation is not causation

One of the most disturbing aspects of math anxiety is its correlation to math achievement. Research has shown repeatedly that math anxiety lowers math performance (Hembree, 1990). This trend negatively affects students’ self-confidence but it also instills a perceived sense of math incompetency. Furthermore, Hembree (1990) concluded that higher math achievement consistently accompanies a reduction in math anxiety. It is crucial to remember that the two constructs of math anxiety and math performance are correlated, but are often perceived as causal. Student attitudes towards math effect levels of anxiety and beliefs about math competence which are some mediating factors that all act on math performance. Students who
dislike math also tend to believe they are not good at it and consequently perform worse than their classmates (Stuart, 2000). Math anxiety affects perceived math competence, and the research has shown that perceived math competence is related to math performance. All these factors are interrelated, and emphasize that the problem of math anxiety, math competence and math achievement are extremely complex. Stuart (2000) contends that people participate in something if they think they are good at it, and to feel good about math, students have to believe that they are good at it. Students’ beliefs about their math skills has a greater impact on their performance than their actual math ability. This resonates with Beilock and Willingham’s (2014) research on math anxiety robbing students of their working memory. Students have great capacity to problem solve and do math problems, but when they are anxious, their working memory cannot operate successfully. Once again, their performance tends to reflect their level of anxiety as opposed to their actual math ability. Sadly, math anxious students tend to attribute their performance to math competence and dismiss their anxiety as a plausible contributing factor.

Research has shown the drawbacks of negative social influences that may affect math anxiety such as teachers and parents, but these influences can also be positive if effective interactions between them and students take place. Stuart (2000) compares math to a sport. She believes that it is 90% mental (one’s math confidence) and 10% physical (one’s math competence in performing math skills). This statement captures the importance of shifting the focus from student inability, to addressing student attitudes. In her study, Stuart (2000) found that once teachers implemented strategies like more group work, cross-subject assignments, math journals and individual conferences, there was a shift in the classroom. Students had improved test scores, but more importantly there was a change in students’ attitudes towards mathematics.
She found that students who had viewed math negatively began to appreciate it and feel more confident about their abilities. In turn, this confidence helped them be more successful in subsequent math tasks (Stuart, 2000). Research also supports that these strategies are more effective once the teacher acknowledges their role in perpetuating math anxiety and stays motivated to understand it (Woodard, 2004). Math anxiety, on both extremes, seems to operate like a domino effect. When math anxiety is high, it negatively affects math confidence, self-efficacy and math achievement. When math anxiety is relieved, it positively affects attitudes towards math, self-confidence and math achievement.

2.3 Gender Differences

Why do gender differences in math anxiety emerge?

Gender differences in math anxiety seem transparent; math anxiety seems more evident in females than males (Hembree, 1990). The research on the rigidity of gender differences exhibited in math anxiety is abundant. Firstly, it is important to address how math anxiety is measured. There are multiple scales used for students of different ages, for example the MARS and SEMA. The MARS, math anxiety rating scale, is generally used to measure math anxiety in adolescents. The SEMA, scale for early mathematics anxiety can be used to measure math anxiety in children between ages 7-9 (Teaching Children Mathematics, 2013). Most of the scales are self-assessment, so it is possible that a mediating factor that causes gender differences to occur is that females might be more willing to admit they have math anxiety than males. Performance scores tend to exhibit gender differences as well. For example, the EQAO has found that females tend to perform better in language arts and males tend to perform better in mathematics and science (Pang & Rogers, 2013). Math anxiety may contribute to these results
since research has shown that girls exhibit more math anxiety than boys (Hembree, 1990). Although math anxiety appears to be more pronounced in females than males, it is crucial that teachers use effective teaching pedagogy for all students in order to relieve math anxiety.

Although math anxiety may emerge in boys and girls for different reasons, the research has found that math anxiety is more prevalent in girls (Hembree, 1990). The results from one study indicated that across all grades, female students report higher math anxiety levels than males. Interestingly, male students in high school exhibited stronger negative behaviours regarding decreases in performance or math avoidance (Hembree, 1990). This may be due to females being more willing to admit anxiety and cope with math anxiety better (Hembree, 1990). Alternatively, other research has shown that in younger grades, females experience more pronounced math anxiety than males (Beilock et. al, 2010). One study found that since there are more female teachers in elementary school, more female students end up being inflicted with math anxiety throughout the course of the year of their schooling. Since girls’ gender ability beliefs play a large role in this effect, female teachers may model gender stereotypes to female students through their math anxieties (Beilock et. al, 2010). It is incumbent on educators, especially female educators with math anxiety, to recognize their behaviours, attitudes and teaching pedagogy when it comes to math in order to avoid passing on gender stereotypes to students.

Math anxieties can emerge in students at different times. Most research has been conducted on students in elementary and high school. Research on the role of parents and teachers in the development of math gender attitudes in students has found that math anxiety can emerge at a much younger age than previously thought. As early as 2nd grade, students begin to
endorse the societal stereotype that math is for boys and not for girls (Gunderson et. al, 2012). Math anxiety could be present as well since research showed 2nd graders with higher math anxiety were associated with lower achievement (Beilock & Willingham’s, 2014). The complexity of this phenomenon is immense, and because it begins at such a young age, it can be detrimental to development. The influence of parents and teachers on the development of math stereotypes and potential math anxiety is profound. Adult expectancies and attributions in accordance with math, impact students’ development of math attitudes along with their own math anxieties and beliefs regarding math ability as a stable trait (Gunderson et. al, 2012). Gender stereotypes are prevalent in households and in classrooms and can be a contribution to the pervasiveness of math anxiety over the lifespan.

**Ability vs Effort**

Often, parent and teacher attributions of success impact children’s own perceptions. Parents and teachers often imply that boys’ success in math is due to ability, while girls’ success in math is due to effort (Gunderson et. al, 2012). This is problematic because it affects how each gender deals with failure and contributes to the apparent gender differences that emerge in math. Boys associate failure with a lack of effort while girls associate failure with a lack of ability (Gunderson et. al, 2012). These attributions that are often transmitted to children through the poor use of language, can play a large role in a child’s attitude towards math in later schooling. As evidenced by aforementioned research, math anxiety is more prevalent in girls than boys and these painful attributions for girls regarding ability and effort can contribute to the perpetuation of math anxiety throughout many their lives.
Teachers and parents implicitly and explicitly endorse these societal views and in turn, instill them in students and children. It is difficult for children to reject these socially transmitted views because their reasoning skills aren’t fully developed. The validity of these views seem more apparent to children if they are coming from authority figures like parents and teachers (Gunderson et. al, 2012). Evidently, gender stereotypes related to math ability, math performance, math competence and math anxiety emerge at a young age and rapidly develop through socialization. Teachers and parents have a strong impact on children, and it is crucial to combat these issues assertively because gender stereotypes regarding math are rigid and long lasting.

*Long term effects of gender differences*

The psychological impact of math anxiety can have long term effects and evolve into an avoidance of math related courses and future careers. The field of social psychology has done significant research on issues like stereotypes and prejudice. Stereotype threat refers to the interference of performance when one is under pressure to perform in a situation where one’s group is afflicted with a stereotype (Spencer et. al, 1998). In stereotype threat, the possibility of being judged while performing usually negatively effects the performance, and a self-fulfilling prophecy ensues. This is extremely relevant to the field of math anxiety and the research that has been done on gender differences and performance on math tasks. Females are stereotyped to be weaker at math while males are stereotyped to be stronger in math. The phenomenon of stereotype threat would infer that when a stereotyped group like women, perform math, they do worse than men because they are worried about being judged and this added pressure acts as a barrier to their success (Spencer, 1998). Stereotype threat and math anxiety are both issues that
Research on stereotype threat has looked at stereotyped groups like African-Americans, Asians and women in math. Spencer et al. (1998) studied stereotype threat to address the misconception that women have lower math ability than men. Women are faced with this stereotype the most when their math skills are exposed to judgement in situations like formal tests. Spencer et. al (1998) ran participants in 3 studies. In the first study, they replicated previous results and showed that women underperformed compared to men on a difficult math test, but did about the same on an easy test. In Study 2, participants were either told there was a significant gender difference in results, told there was no gender differences in results, or told neither. When participants were told there was no gender difference, men and women performed the same. Women performed slightly worse when they were informed that there were gender differences. Study 3 had a group that was told there were no gender differences and a control group. Women performed slightly worse in the control group. The researchers provide compelling evidence for the existence of stereotype threat of women in math. They also find it plausible that anxiety could be a mediating factor that produced these results. Similar to research done on math anxiety, stereotype threat occurs when a person feels like their ability is being judged.

The theme of ability being judged is consistent with the research on math anxiety, because people with math anxiety often attribute their failure as a lack of ability (Gunderson et. al, 2012). The theme of ability is also central to stereotype threat, since students experiencing stereotype threat feel like their ability is being judged when they are completing a task that the
group they belong to is stereotyped to perform worse (Spencer, 1999). It is evident that the complex issue of math anxiety can have overlapping and interconnecting factors that contribute to it. The gender gap is significant with girls experiencing more math anxiety than boys at a young age, and women being faced with stereotype threat at later age. This is a pervasive issue in society that is caused by the interaction of psychological, cognitive and social forces that effect an individual’s academic success, self-confidence and math achievement.

Math anxiety at a young age can be layered with stereotype threat at an older age, and these interacting factors may all be reasons why there are less women in STEM (Science Technology Engineering and Math) fields. In 2009 in the U.S.A, only 16.5% of students who graduated with an engineering degree were women and 19.3% who graduated from physics degrees were women (Heilbronner, 2013). Women are still almost equally getting undergraduate degrees, but are extremely underrepresented in the math-related fields. In Canada, women accounted for 39% of university graduates aged 25 to 34 with a STEM degree in 2011 compared to 66% who graduated from non-STEM programs (Hango, 2013). Students’ early math experiences tend to inform their academic decisions later on, This is evidenced by the research indicating that students who chose a STEM university program had a higher PISA (Programme for International Student Assessment) math score at age 15 (Hango, 2013). Additionally, these students had higher math marks in high school and had a more positive perception of their mathematical ability (Hango, 2013). Although not explicitly stated, experiences of math anxiety in students during earlier schooling are likely to inform later academic choices. Math anxiety can manifest into math avoidance in many females, and this may eventually contribute to the lack of women in STEM programs.
2.4 Instructionally Responding to Students’ Experience of Math Anxiety

Practical Implications

It is evident that math anxiety is a pervasive and damaging phenomenon that begins in the classroom but continues to effect students out of the classroom. The research on the practical implications of teaching strategies that can be used in the classroom to combat math anxiety is vast. This is helpful for teachers because research and resources are available and growing in popularity. Beilock & Willingham (2014) address the imminent concern about how everyday teachers combat math anxiety in the classroom. Firstly, it is essential to acknowledge that math anxiety is real and address it as a serious problem. A preventative measure that can be taken to guard against the development of math anxiety is enhancing basic numerical and spatial processing. Students need to have basic content knowledge in math to pursue higher grades successfully (Beilock & Willingham, 2014). The authors also found that another proactive strategy that teachers can implement are exercises that can boost math competencies and regulate anxiety. For example, making learning math fun through games or taking time to participate in mindfulness. Additionally, the authors recommend encouraging parents to engage with students about math. Previous research has shown the powerful impact parent influence has on student success, so parents should capitalize on this finding by positively engaging their children in math related tasks. This notion is similar to Gunderson et al.’s (2012) stance that ensues that parents and teachers represent two major environmental influences on the formation of children’s academic attitudes. It is essential that positive math attitudes do not begin and end in the classroom, but extend to a child’s real world. For example, relating math to sports such as using a football tackling strategy to explain the relevance of Pythagorean Theorem (NBC Learn, 2010).
Parents should also be aware that their own math anxiety can be socially transmitted and refrain from labelling themselves as “bad at math”. Stuart (2000) reinforces the belief that students are more likely to have positive experiences if their parents are supportive in their math experiences. Additionally, teachers who feel math anxious need to acknowledge their discomfort but be mindful not to pass it on to their students through their behaviour and language.

Teachers in the classroom need to use strategies to prevent math anxiety from emerging, but be equipped with strategies to combat it if and when it occurs. Beilock & Willingham (2014) advocate for giving students the opportunity to write freely about their emotions and anxieties regarding upcoming tests. This could be in the form of a routinized math journal or providing opportunities for thoughtful reflection during the day. Assessment on math journals can accommodate for students who have strong literacy skills and can capitalize on this strength to excel in math. Research has also found that when students can hone in on other academic strengths in math class, like a visual arts assignment that integrates math concepts, they feel more successful (Stuart, 2000). Students can begin to attribute their efforts to success in math when they are confident in their work. Beilock & Willingham (2014) emphasize the benefits of writing as it can be used to alleviate negative thoughts, and therefore make more room for working memory to be used to boost math performance. Anxiety often consumes valuable working memory space and provides less resources for students to problem solve or do math questions (Beilock & Willingham, 2014).

Teacher language is an example of another factor that can either contribute or alleviate math anxiety in students. When students are struggling, although a natural instinct, teachers should refrain from consolation, for example “It’s OK, not everyone can be good at these types
of problems”. This might validate the student’s belief that they are “bad at math” (Beilock & Willingham, 2014). Instead, teachers should acknowledge the student’s experience and focus on the process. In reality, this can be difficult to monitor regularly but if teachers are aware of how subtle differences in their language can impact a student’s success, progress can ensue.

**Effective Teaching Pedagogy**

Teachers can also use math teaching resources to creatively lesson plan and engage students in the subject. Students’ attitudes about math will contribute to their engagement in the classroom, and their attitudes will partially drive their success. Stuart (2000) outlines some teaching pedagogy that helps create a healthy and successful math environment for students. In her research, she found that most students benefitted from using manipulatives and working in cooperative groups. Traditional styles of teaching math may include limited group work and hands on learning while lacking a student centred approach in our math classrooms. Teachers should engage in students’ prior knowledge by planning and executing meaningful mental sets and encouraging them to work in cooperative groups in problem solving situations. Stuart (2000) also emphasized the importance of individual conferences. These personal interactions can empower students because they receive specific feedback. It is difficult to implement this regularly in the classroom, but keeping this goal in mind to accomplish even once a term could have positive effects on students.

Cross-subject integration in math is important because it assists in differentiated instruction and accommodates for students’ varied learning styles (Blazer, 2011). By practicing cross-subject integration, teachers can better relate math to real life and encourage students to make personal connections to math (Blazer, 2011). These strategies will enhance a student’s
experience in math because it puts math into a context they can relate to, and they can witness the use of math in everyday life. In a diverse society, classrooms are often filled with different cultures, religions and learners. Iliev & D’Angelo (2014) explore teaching math through multicultural literature as it can appropriately reflect different populations in the classroom. Students begin to make multicultural connections to math and the real world, and may be more invested in course material if they feel personally connected to it. Engaging students in math through particular hobbies or interests may also alleviate math anxiety and foster success. For example, one study explores cooking with students as opportunity to teach math. Students see the real life application of math, utilizes multi-sensory learning and can explore concepts like measurement and fractions Smith (1974). Through engaging students in multisensory learning as well as encouraging students to make real life connections to math, math anxiety can effectively be reduced and success in math can be fostered.

2.5 Conclusion

In this literature review I looked at research on how many anxiety develops in students and the active role teachers can take to instructionally respond to it. Firstly, I began by defining math anxiety and exploring various causes of math anxiety. The causes of math anxiety are both cognitive and social, with interacting factors influencing it. The lack of working memory to apply to math problems due to anxiety is one explanation for lower math performance. Social influences like teacher and parent expectations, gender norms and stereotypes all contribute to the formation and elevation of math anxiety. Math anxiety is more pronounced in females than males because of an interaction of all these causes.
I also address the pertinent problem of math anxiety and how it continues to affect people in their adolescence and adult lives. Elementary school teachers are primarily women, and those that are math anxious still have to teach math to their students. This anxiety often transfers to students, more specifically, to girls more than boys. Women are often faced with stereotype threat when they are in post-secondary education, because society stereotypes them as being weaker in math, therefore they perform worse in high stress situations where their math skills are being judged. Math anxiety may also be a contributing factor to this weaker performance along with the statistics that support that there is an underrepresentation of women in STEM programs and careers.

Finally, I discuss what teachers can do in their classroom to combat math anxiety. Research has primarily focused on teachers’ attitudes, language and teaching pedagogies. Teachers can foster positive math classes by engaging their students with math material, associating math with positivity and focusing on the process of work rather than solely the product. Teachers can also capitalize on successful math teaching strategies like collaborative group work, math journals, cross-subject integration and the use of manipulatives.

Future research on math anxiety can focus on ways to counter this issue in schools and at homes. It is often acceptable to say “I’m bad at math” but unheard of to say “I’m bad at reading”. Math has a stigma associated with it, and due to this, math anxiety is not addressed to the capacity it needs to be. A Chinese proverb states “Tell me mathematics and I forget; show me mathematics and I may remember; involve me …and I will understand mathematics” (Williams, 1988, p. 101). This accentuates the need for a revolutionary change in math teaching strategies. In order for students to succeed in math, they need to be actively engaged in the process of
learning it. Students obtain positive attitudes when they feel successful in a subject. Success in math can only fully be achieved once the perpetuating cycle of math anxiety is alleviated. With my research, I hope to contribute to the existing body of work on math anxiety by exploring how the trend of math anxiety is pervasive in and out of our school system. Interestingly, I will look at how the gender of both the student and teacher can affect a students’ experience of math anxiety. Math anxiety can be the barrier to success for many students and I hope to explore different teaching strategies that can be used to instructionally respond to a student’s unique experience of math anxiety.


Chapter 3: Methodology

3.0 Introduction (Chapter Overview)

In this chapter, I will overview the key aspects of the research methodology I used in my study. I begin by reviewing the general research approach, procedures and data collection. After this, I will specify the criteria used for participant sampling and recruitment. I will then explain data analysis procedures and review the ethical considerations taken for my study. Then, I outline the pros and cons of the methodology. Finally, I conclude the chapter by providing a brief overview of key methodological decisions and the rationale pertaining to them given the research purpose and questions.

3.1 Research Approach & Procedures

This study was conducted as a qualitative research study using semi structured interviews. The use of a qualitative approach in this research allows the inquiry to represent a mode of social and human science (Creswell, 2013). This is a valuable form of research because it has the potential to engage the lives and experiences of participants through thoughtful interviews. The study sought out to understand teacher perspectives on the experience of math anxiety in the classroom. By using a qualitative approach, I am able to learn from teachers about their individual experience supporting students with math anxiety through interview questions that invite them to share their perspectives and practices. The study collected data from the interviews, and made connections to existing research on education and psychology. Qualitative research calls for the difficult task of acknowledging assumptions that we all have and then actively deciding whether to include them in research or not (Creswell, 2013). This was
especially important when conducting interviews with teachers about math anxiety because teachers play an important role in the formation and sustenance of math anxiety in students.

### 3.2 Instruments of Data Collection

This study was conducted using the semi-structured interview protocol. Semi-structured interviews provide the opportunity to hear about participants’ lived experiences (Creswell, 2007) and will therefore provide in depth data for this study. The semi-structured format allows for flexibility for the researcher to develop and execute an interview that pertains to their research focus. Additionally, it leaves valuable time for participants to be reflexive and elaborate on their experiences. I developed an interview protocol (see Appendix B). The protocol was developed by reviewing the existing research on effective teaching pedagogy related to math. Specifically, I focused on best practices that research has shown reduces math anxiety in the classroom and help to increase math performance. Each participant will be asked 12-15 questions about their experiences as a math educator regarding math anxiety, teaching practices and strategies to combat the cycle of math anxiety that goes beyond the four walls of the classroom.

Some of the questions that will be asked to participants are:

- From your work as a teacher, have you noticed a difference in math anxiety between boys and girls? If so, how does math anxiety manifest differently in boys and girls?

- How do you think parent interactions influence attitudes about math in and out of the classroom?

- What teaching strategies do you use to engage and accommodate for students experiencing math anxiety?
3.4 Participants

In this section, I review the sampling criteria I established for effective participant recruitment as well as various avenues for teacher recruitment.

Sampling Criteria

In order to gain in depth information about my research topic, I have determined strategic sampling criteria for my participants.

- Teachers who have a minimum of 5 years teaching experience in math education
- Teachers will be teaching math at different grade levels (grades 4-12)
- Teachers will have a demonstrated commitment to responding to students’ experience of math anxiety (e.g. they have presented or conducted workshops on this topic or they have conducted graduate research in this area, or they have contributed to curriculum development in this area…)

The criteria for these participants needs to be met in order to extract teaching experiences that interact closely with the phenomenon of math anxiety. Additionally, by interviewing teachers of different grade levels, I was able to explore teachers’ perspectives on how math anxiety manifests in students at different levels. It is important that these teachers have had math as a primary assignment for most of their teaching career. Their past experiences will influence their comfort with math and consequently reflect on their comfort with teaching math. I also want to explore teacher perspectives on the relationship between math anxiety and gender.
Sampling procedures

I contacted teacher associates and/or principals, along with teachers I know personally, and provided them with an overview of my research study. I provided the participant criteria in order to confirm that my participants meet the necessary criteria. I was mindful of biased selection and ensured that I provided my research topic information readily as opposed to asking individuals for personal information first.

Due to the small nature of this study, I relied on convenience sampling for the majority of my participants. I utilized my connections with previous teachers and mentors, as well as my current colleagues in the Masters of Teachers program and any associate teachers that I meet during practicum. These personal connections are beneficial because they will allow for more in depth interviews and help create a safe space for participants. Since I have set criteria for my participants I am also purposive sampling for this study. Participants are aware they have been selected because they meet certain criteria therefore one limitation to this could be that it is evident in the interview that the agenda for discussion is set by the researcher. Although selecting participants based on criteria is a necessity for this study, a con to this is that there will be a degree of control that stands with the researcher and this may affect to proceedings of the interview (Denscombe, 2003).

Participant bios

I interviewed 2 participants for this study. One participant is a retired secondary school math teacher who ended her career as head of the math department in her school. The other participant has taught math at the secondary level but currently is a Grade 7 gifted teacher in an elementary school. She has previously taught rotary math from Grade 7-8.
3.5 Data Analysis

According to Creswell (2007), data analysis in qualitative research consist of collecting and organizing data, and then extracting themes from the data through the process of coding and finally representing the data in a form such as discussion. For the purposes of this study, prior to analyzing data, the interviews have to be transcribed. Then the data will be coded and reduced to meaningful segments and be assigned names. Then codes will be combined into broader categories and themes. Data will be displayed in various data graphs, tables and charts in order to make comparisons (Creswell, 2007). I will synthesize any themes and categories as necessary, and eventually focus on making meaning about my findings relative to the existing research.

Data collection is a crucial step in the qualitative research process. Creswell (2007) describes the concerns about data analysis in qualitative research as being seen as intuitive and serendipitous at times. He describes the data analysis process as a spiral beginning with data management. It is crucial for all data to be organized in files and transcribed accurately using computer programs for assistance. Next, the researcher must get a sense of the entire data base and this includes reading transcripts several times. The coding process is key during this time as researchers develop tentative codes, and begin to categorize their data. After this, the data will be categorized which will then lay the groundwork for interpretation. Through interpretation, the researcher develops themes and begins to make meaning of their data (Creswell, 2007). Finally, the researcher decides the most effective ways to present their interpretation of the data.

3.6 Ethical Review Procedures

For the ethical purposes of this study, each participant had the right to withdraw their data contribution at any time. To protect the identities of the participants, they were each given a
pseudonym. Under the ethical procedures, I selected participants solely from my sampling criteria. I also acknowledged the power dynamics and ensured to build rapport with the participants prior to the interview. There are no known risks involved with participation in this study. Given the research topic, there is the possibility of minimal risk given that there may be triggers for anxiety and/or emotional reactions thus making them feel vulnerable. To minimize this potential risk, I will remind participants that they may refrain from answering any question. Participants will also be asked to sign a consent letter (Appendix A), giving their consent to be interviewed as well as audio recorded. The consent letter provides them with an overview of the study, addresses ethical implications and specifies expectations of the participants.

Participants will have the opportunity to review the transcripts to clarify or retract any statements before data analysis. All data, including audio recordings, will be stored on the researcher’s password-protected computer and will be destroyed after five years. Only my course instructor and I will have access to the raw data.

3.7 Methodological Limitations

There are a few methodological limitations of this study. The interviews are based on individual teachers’ experience and cannot be generalized to the rest of the population. Although they will shed light on math anxiety, their data cannot be attributed to the phenomenon of math anxiety as a whole. Additionally, the participants are aware of my research purpose and interests and this could make their responses biased. Participants might also be more inclined to say that their teaching practices are aligned with what the research says is best practices for reducing math anxiety, but what they actually do in practice may differ.
As previously mentioned, a limitation to this study is the small sample size and the type of participants that were ethically approved. I was not able to interview parents or students for this study despite their major contribution to the perpetuating cycle of math anxiety. As a result, the data collected from the teachers reflect just one component of the complex issue that is math anxiety. Another limitation to this study is that due to ethical procedures, the research will be conducted using a single research method. Interviews will be the sole research method and therefore more quantitative data produced from methods such as surveys will not be included.

A strength to this methodology is that participants have the opportunity shed light on a specific phenomenon while reflecting on their own teaching practices. By using a qualitative approach, the stories of participants will bring depth to the research and provide a very humanistic perspective to the research topic (Creswell, 2007). This will benefit my qualitative study because the data will be rich with personal narratives that are relatable to everyday life.

3.8 Conclusion: Brief Overview and Preview of what is next

In this chapter, I provided a brief overview of the research methodology that was used for this study. I began by giving an introduction to my research and stating my research question which addresses how teachers combat the perpetuating cycle of math anxiety within students in their classroom. I reviewed the overall procedure of the qualitative study and described the process of determining my research questions. I then reviewed the sampling criteria and participant bias for my interviewees. I referred to the data analysis that took place along with the ethical review procedures that were considered. I discussed the methodological limitations of the study some of which included teacher bias and sample size.

Next, in Chapter 4 I will report the findings.
Chapter 4 - Findings

4.0 Introduction

In this chapter I am reporting the findings of two qualitative interviews I conducted with math educators. In order to fulfill my criteria, these were both teachers who had taught math for at least 5 years. Mrs. Molly is a retired secondary math teacher who was head of the math department in her school near the end of her career. Mrs. Nebb is currently a Grade 7 Gifted teacher who also teaches computers on rotary. She has taught math in the secondary level in a different system, and began teaching rotary math here in elementary school. I interviewed these two women because I was investigating how teachers instructionally respond to students’ experience of math anxiety. I addressed the background of each teacher in order to know what prior experiences they brought to the classroom when teaching math. I inquired about their views on math anxiety, math competence, gender differences in students, impact of gender of math teacher, parent influences, personal experiences informing their practice and effective teaching strategies to respond to students’ experience of math anxiety. These interviews often touched on similar findings that I revealed in my literature review, but at times these personal stories and the evidence in the literature review contradicted each other. In this chapter I will report the interactions between the interviews, the literature review and the overall significance of various themes that emerged during this qualitative study

4.1 Definition of Math Anxiety

A student’s experience of math anxiety can differ greatly depending on their individual differences. According to the research, math anxiety can arise due to the inability to problem solve caused by the lack of working memory space (Beilock & Willingham, 2014). It is also
evident in the research that external factors such as parent and teacher interactions can influence a student’s experience of math anxiety (Sparks, 2011). Although it is difficult to know how each student arrives to the manifestation of math anxiety, it is important to be able to recognize when a student is experiencing math anxiety in the classroom in order to instructionally respond to them effectively. When participants were asked to define math anxiety, they similarly described the affective part of the experience, because that is what is visible to them. When asked to provide a definition of math anxiety, participants used phrases such as “blanking out” or the feeling of “freezing”. Similarly, research has also provided an affective definition of math anxiety referring to it as a feeling of “sudden death” (Stuart, 2000). These affective emotions also impact a student’s ability to do math. Mrs. Molly describes math anxiety as an inability to learn because the anxiety in someone’s head is telling them they can’t do it. Mrs. Molly also recalls how a student with math anxiety may display an unwillingness to put anything down on paper due to the fear of getting it wrong. Despite potentially knowing the answer, a student cannot access the answer because of their math anxiety. Research has shown that students are more willing to participate in something if they think they are good at it (Stuart, 2000), and if students experience math anxiety and cannot access their math knowledge, they are unlikely to feel good at it.

Students experiencing math anxiety are aware of the importance of math, and this can often lead to those affective reactions. Interestingly, Mrs. Nebb addressed the issue of math being near the top of an academic hierarchy by referring to problem solving in math as a matter of honour. This is significant because 93% of Americans indicated that they experience some level of math anxiety (Blazer, 2011) in spite of the societal importance of math. Math anxiety is prevalent in today’s society, and it is crucial for teachers to be aware of how they define math
anxiety since students can exhibit it in a variety of ways. Teachers will be able to better respond to a student’s experience of math anxiety if they recognize the serious impact it can have.

4.2 Math Anxiety and Math Competence

From the definitions of math anxiety, it is clear that when a student experiences math anxiety, it effects their ability to do math. It is important to note that there is a distinction to be made between math anxiety and math competence. Hembree (1990) describes how math anxiety not only lowers math performance, but more importantly instills a perceived sense of math incompetency. This is problematic because it is often this perceived sense of math incompetency that leads students to believe they can’t do math, even if they have the ability to do it. Mrs. Molly says that a common phrase a math anxious student uses is simply, “I can’t do it.” The extremity of this statement is driven by the affective nature of math anxiety, and the perceived sense of incompetence a student has when they are not able to solve math problems. It is difficult for a student, and possibly teacher, to realize that this inability to solve math problems is due to the anxiety and not to ability. Although the research states that math anxiety lowers math performance, Mrs. Molly describes a contradictory scenario in which a student is motivated by their math anxiety. Mrs. Molly recalls a student that worked harder in math than other subjects because they were aware they struggled in it. Mrs. Molly admits that this is more of an exception than the rule, but does recognize how math anxiety in this particular student created a sense of ownership and labelled her as an “over achiever”. Unfortunately, the research does not delve much into how math anxiety can be honed in as motivation perhaps because there are few cases that this applies to.
It is evident that both participants were aware of the relationship between perceived math competence and math performance. Mrs. Nebb describes how a few selective words of encouragement to a student who suffered from math anxiety, helped them believe that they could do math. Mrs. Nebb describes how this student’s perspective changed when they started to believe themselves that they could accomplish tasks in math if they perceived that they could. Research supports the claim of this relationship since it has been shown that math anxiety effects perceived math competence, and math competence is related to math performance (Stuart, 2000). This is an important aspect of math anxiety because it is the relationship that many students fail to comprehend. If teachers are aware of the relationship between math anxiety, perceived math competence and math performance, they will be able to advocate for students who cannot advocate for themselves.

4.3 Gender Differences in Math Anxiety

A common trend that emerges in the research regarding math anxiety is gender differences. Research has shown that girls exhibit more math anxiety than boys (Hembree, 1990). It is common knowledge that stereotypes exist in education, and a recurring stereotype is that girls are simply “bad at math”. It is more likely that they are simply more math anxious which in turn affects their perceived math competence and math performance. A more recent study found that females tend to perform better in language arts and males tend to perform better in mathematics and science in the EQAO (Pang & Rogers, 2013). Whether or not these trends occur to fulfill societal norms and expectations, or have actual validity, gender differences are an important issue in math anxiety. Interestingly enough, when asked about gender differences in math anxiety, both participants quite confidently stated that they do not believe that there are significant gender differences in boys and girls when it comes to math anxiety. Mrs. Molly did
recognize that it is possible that boys and girls may manifest their math anxiety differently due to social norms, but it was clear that they both experienced it. Mrs. Molly once again referred to that external pressure of having to be good at subjects like math and science, and how society expects boys to excel at those subjects. Consequently, boys might feel math anxious and girls are void of that because society claims that “girls can’t do math”. Mrs. Molly claims that girls battle with math anxiety in order to prove it to themselves they can do math since they do not experience as much external pressure. Mrs. Molly also describes how math anxiety is more noticeable in girls because boys tend to act macho or act out because societal norms do not commend boys to express their feelings and vulnerabilities. Instead, when boys act out or misbehave, they can blame their poor math performance on that as opposed to their math anxiety. Mrs. Molly recognizes this attempt to mask math anxiety in boys and claims that what is actually happening is “he’s acting out because he can’t do it, not he can’t do it because he’s acting out”. This is a powerful message to convey because as previously mentioned, math anxiety can manifest in multiple fashions. More often than not, it is in the form of noticeable, affective reactions such as seeming nervous and fearful. In this case, students may not appear to be experiencing math anxiety because they are covering it up with behaviour that will often be reprimanded by the teacher as opposed to consoled. Although the research and the interviews contradicted each other in terms of the prevalence of gender differences, research does support the notion that boys and girls cope with math anxiety differently. Hembree (1990) found that boys in high school exhibited stronger negative behaviours regarding math avoidance and girls being more willing to admit anxiety as well as cope with math anxiety more effectively. This notion aligns with Mrs. Molly’s views on the difference in coping strategies of math anxiety.
between boys and girls, and signifies that gender is still an important factor to consider in
phenomenon of math anxiety.

Mrs. Nebb also stated that she did not notice any major gender differences in math
anxiety. Mrs. Nebb states that she has taught exceptional math students of both genders as well
as math anxious students of both genders. Unlike Mrs. Molly, who was a secondary school
teacher, Mrs. Nebb did not notice a large difference in coping strategies between boys and girls
in elementary school. It is worth mentioning that the grade level these teachers are drawing their
experiences from can impact their views on math anxiety. Students tend to be more self-aware in
high school and can therefore be more visible about their coping strategies. Both participants
were quite transparent on their views about gender differences in math and it is interesting that
these opinions were not significantly represented in the research on gender differences in math
anxiety. Lastly, it is important to remember that these are the views of 2 educators and cannot be
generalized to the rest of the teaching population.

4.4 Impact of Gender of Math Teacher on Math Anxiety

Both Participants in this qualitative study were female. This is important to mention
because a common theme that came up in the research was the impact of the gender of the math
teacher on a student’s experience of math anxiety. As previously mentioned, girls exhibit more
math anxiety than boys (Hembree, 1990) and this may relate to the unbalanced ratio of male to
female teachers. In the U.S.A, more than 90% of elementary teachers are female. Children are
more likely to emulate behaviours and attitudes from same-sex adults and this may be why girls
perceive math anxiety in their female teachers more than boys (Beilock et al., 2010). Naturally,
the participants were questioned on their opinion of this trend and this yielded a number of
interesting responses. Mrs. Nebb quite firmly believed that it was not the gender of the math teacher that contributed to a student’s experience of math anxiety, but rather the professional level of understanding of math. In other words, a teacher’s math content knowledge is a stronger determinant of the level of math anxiety that ensues in their students. Mrs. Nebb also addressed the fact that because there are significantly more female teachers, it is natural that research shows that female teachers transfer more math anxiety to students. Mrs. Nebb suggested that in order to get a more accurate depiction of the effect of the gender of the math teacher, research should look at all the strong math teachers, male and female, to extract a deeper understanding of the issue.

Male and female math teachers may in fact have a different impact on students. This may be due to how a student identifies with their teacher, if they lack a strong parent figure of a certain gender, or just their personal preference. In terms of math anxiety, although the research shows female teachers tend to transfer math anxiety to students, especially female students (Beilock et. al, 2010), Mrs. Molly had a very different opinion on this controversial topic. While talking about male math teachers, Mrs. Molly stated that “they get excellent results from their excellent students”. This statement is thought provoking and may be the reason that male math teachers get classified as “better”. Mrs. Molly went on to explain that in her experience, most male math teachers lack patience and empathy when dealing with students who experience math anxiety, therefore dispelling the option for a student to perform well despite experiencing math anxiety. Mrs. Molly went as far as to say that she would classify more male math teachers in her experience as bullies than female math teachers. The research does not seem to touch on this topic, but rather focuses on the female teachers who experience math anxiety themselves. According to Mrs. Molly, this lack of empathy may shift after a teacher has kids themselves, for
example, a male teacher could be more empathetic to students once they have their own child. It is evident that more research needs to be done in this area because one teacher’s voice cannot be generalized to the bigger picture. It is worth mentioning this opinion because it does address the fact that not all students receive proper support and instruction when experiencing math anxiety due to who their teacher is as a person. In order to effectively instructionally respond to students’ experiences of math anxiety, all teachers need to be well prepared to deal with students on a wide spectrum of ability.

**4.5 Parent Influence on Math Anxiety**

Although teachers play a large role in a child’s education, parents also strongly influence a child’s developmental years. Naturally, these years are formative in terms of a student’s development emotionally, socially, mentally and academically. Parents and teachers play a major role in all these developmental stages simply because they interact with the child the most. As previously mentioned, one major contributing factor to math anxiety can be the external influences of language, behaviour and attitudes of parents and teachers. Research has shown that adult attributions in accordance with math impact students’ development of attitudes and beliefs about math as well as their math anxieties (Gunderson et. al, 2012). The relationship between parents, teachers and students can be pivotal in a child’s route to academic success.

Unfortunately, a child’s experience at home impacts their ability to learn in school and can often form barriers for children.

It is concerning that math anxiety perpetuates through generations due to the biological and social factors that are built into it, and children often internalize the negative feelings about math from the key adults in their life (Sparks, 2011). When asked about the impact parents have
on a child’s experience of math anxiety in the classroom, both participants echo the sentiment of the research by acknowledging the large impact parents can have. In large, the participants also voiced frustration with the role that parents tend to play in a child’s academic life. Mrs. Molly described her frustration of people readily stating that they ‘can’t do math’ but almost never saying they ‘can’t read’. It is accepted in society for people to willingly admit if they feel they are not good at math and this language can be detrimental to a child’s own perception of their math ability. Mrs. Molly also talked about how negative language from parents, whether they have low or high expectations from their child in math, can impact a child’s attitude towards math. On the contrary, parents also have the opportunity to positively impact their child’s experience of math by making math a positive experience at home. Mrs. Nebb recalls her own experience as a parent and the effort she took to integrate math in everyday life in order to make it relevant to the child. This notion is supported by the research which contends that when students make real life connections to math, they feel more invested in the subject (Iliev & D’Angelo, 2014). If students feel inclined to engage in math at home, it will make it less daunting for them at school. Parents play a big role in how students perceive their own math abilities, and it is important to recognize how easily impacted a student can be by the actions, language, and behaviours of the adults around them.

### 4.6 How Personal Experiences Inform Teaching Pedagogy

Teachers bring a wide variety of experiences with them into the classroom. A part of what makes teaching so unique, is the fact that each teacher has a style and story that influences their teaching practice. In terms of math anxiety, it was interesting to question the participants on their own experiences of math anxiety and how that potentially informed their teaching practice. Mrs. Molly describes a certain catalyst for her as a student and young teacher when she
encountered and older male teacher who strongly believed that girls couldn’t do math. Mrs. Molly says that this adversity motivated her to succeed in math and eventually lend her talents to the teaching profession. Mrs. Molly also describes feeling anxious in other classes when she was singled out in front of her peers, and vowed to herself never to do that in her own practice. This is significant because these memories and personal experiences of anxiety helped her instructionally respond to students experiencing anxiety. Interestingly, the research touched more on the danger of the teacher experiencing math anxiety as opposed to the potential of personal experiences positively influencing the class. Mrs. Nebb also describes her math anxiety when specifically doing problem solving. Ironically, she now deems problem solving to be one of the core aspects of her math teaching practice. It is safe to say that the anxieties that these participants faced in the past helped shape the educators they became later on. They also have a better understanding of how math anxiety can affect a student’s ability to learn which in turn can help them support the student more effectively. Research has shown that in order to have a positive influence on students’ experiences of math anxiety, it is crucial recognize some of the causes of math anxiety (Woodard, 2004). Naturally, educators that have experienced anxiety themselves will be more prone to recognizing it in students and therefore more prepared to instructionally respond to those students.

4.7 Effective Teaching Pedagogy

Teachers are faced with the task of teaching students that fall on a wide spectrum of ability. It is difficult to manage differentiated instruction and also be able to instructionally respond to student’s experience of math anxiety. If teachers are aware of the complexity of math anxiety and all the factors that can contribute to it, they can be more prepared to support students. Additionally, they can also be proactive in their teaching practices to create a math
HOW DO TEACHERS INSTRUCTIONALLY RESPOND TO STUDENTS’ EXPERIENCE OF MATH ANXIETY?

positive class where students feel empowered. Both participants described ways that they fostered a math positive class. Mrs. Molly recalls how her own anxiety was triggered when she used to be singled out in class and vowed to never do that in her own practice. Similarly, Mrs. Nebb described the importance of building community in the classroom so students feel like they can make mistakes. She describes the fearfulness of making mistakes in math because of the obsession of always finding the right answer. Mrs. Nebb actively engages students in a lot of problem solving, puzzles and games so that students learn how to focus on the process more than the product. Not only does research commend this teaching pedagogy, it also describes that using proactive strategies such as math games and mindfulness can boost math competencies and regulate anxiety (Beilock & Willingham, 2014). Including math activities and games not only fosters a math positive attitude but will also enhance the teacher’s experience. These proactive strategies create a foundation for a safe learning environment that cultivates a sense of positivity and inclusion when it comes to math. Research has shown that teachers must capitalize on their role of being a positive influence. Teachers can display positive attitudes towards math which can contribute to lower levels of math anxiety. Lower anxiety can lead to enjoyment of the subject and higher math achievement (Hembree, 1990). It is evident that these proactive strategies are integral to create a platform for students to learn math, feel successful and regulate anxiety levels.

Finally when asked about specific teaching strategies used, both participants described different techniques but similar end goals. Similar to doing a math problem, everyone’s process may be different even though they reach the same answer. Mrs. Molly acknowledged that although collaborate group work can be ideal, it’s not always realistic. She found that in her secondary math classes, group work was very time consuming and did not always yield the
desired results. Consequently, she would spend more time re-teaching concepts and trying to classroom manage. This may be due to the increased time pressure when teaching in a secondary school where classes are capped at 75 minutes. Mrs. Nebb teaches in an elementary setting which often allows for more flexible time periods. Mrs. Nebb advocates for group work stating that it helps relieve math anxiety when she is able to make strategic groupings. According to the research, cooperative groups and individual conferencing in math can shift students’ attitudes towards math (Stuart, 2000). Both participants described the importance of individual conferencing despite their difference in opinion on collaborative group work.

The participant were also asked to provide some advice for new math teachers and gave some tips and tricks they use in the classroom. Mrs. Molly emphasizes the importance of having structure and being thorough in a math class. For example, writing down every single step of a math problem can seem redundant, but can relieve students of anxiety because they can stay on track. Exhibiting this patience and understanding also invites students to ask questions in class and feel safe in their learning environment. Mrs. Molly also addressed praise and encouragement, and the importance of capitalizing on small successes and playing to a student’s strengths. This may be in the form of integrating cross curricular assignments so that a student can hone in on other academic strengths and be able to attribute that feeling of success to math (Stuart, 2000). Mrs. Nebb conferred with Mrs. Molly about selective encouragement, and also believed strongly in understanding the basics of math first. It is essential to build on a student’s prior knowledge to engage students in the material (Stuart, 2000). Interestingly, Mrs. Nebb also attempts to use multiple math resources to supplement her lessons so that students stay engaged and never know what to expect while Mrs. Molly expressed admiration for teachers who are innovative with their teaching styles. Although these participants seem to have different
approaches to teaching math, they both are ferociously committed to creating a math positive classroom where they can ultimately respond to all student needs, especially those who experience math anxiety.

4.8 Conclusion

After conducting an extensive literature review on how teachers instructionally respond to students’ experience of math anxiety, I interviewed 2 math educators on the same topic. Throughout the interviews, many themes emerged such as the definition of math anxiety, the relationship between math anxiety and math competence, gender differences in students and teachers, parental influence on math anxiety, personal experiences of anxiety informing teaching practice, and finally effective teaching pedagogy. Some of these themes are interrelated such as how the personal experiences of anxiety from these teachers ultimately helped define what they view as effective teaching pedagogy. Additionally, the issue of gender was addressed between male and female students as well as male and female teachers. The literature is extensive on these gender differences, and because the participants’ personal stories contradicted the literature, it is evident that the topic of gender in math anxiety needs to be further researched. Many of the difference in opinions between participants can partially be attributed to their teaching experience being in different settings. Elementary and secondary school can be two very different playing fields, especially when it comes to math. This became evident as Mrs. Molly, the secondary teacher, often addressed time constraints as a concern due to set periods while this didn’t come up with Mrs. Nebb who teaches in elementary school. Although these teachers’ experience is with different ages, they both have had students in their class who experience math anxiety. Just like the literature, these teachers recognize the seriousness of math
anxiety and are dedicated to instructionally responding to these students by using their personal experience, knowledge on math anxiety and expertise in the math teaching field.
Chapter 5: Discussion

5.0 Introduction/Overview

Imagine a classroom where every subject was equally valued by students and teachers. Now imagine teaching students a math lesson that did not trigger any anxiety from students or yourself, as the teacher. Math anxiety can feel like “sudden death” (Stuart, 2000) and through research, interviews and personal experience, it is a very real and pertinent issue in today’s world. The onset of math anxiety is generally in a classroom, but is easily transferred to post-secondary education as well as the workforce. Throughout this research project, I have been investigating how teachers instructionally respond to students’ experience of math anxiety in the classroom. Throughout my research I have focused on unpacking this question by uncovering the definition of math anxiety, how it manifests in students, the relationship between math anxiety and math competence, and how teachers and parents play a role in this cycle. After interviewing 2 teachers in-depth about their perspective on math anxiety, my findings were sometimes affirmed and other times challenged by the literature. In this chapter I will review my findings from Chapter 4 as well as discuss the implications of those findings. More importantly, I will unpack the broad and narrow implications regarding the societal value of the issue of math anxiety. Based on my research and findings, I will then make recommendations for various stakeholders that factor into math anxiety and how we can create a more math positive culture in and out of the classroom. Finally, I will identify areas for further research on this topic.

5.1 Overview of Key Findings and their Significance

In order to best represent participant voices while upholding the credibility of the research, Chapter 4 is an analysis on my overall findings of how teachers instructionally respond to students’ experience of math anxiety. Throughout my research and interviews, several themes
emerged that engaged the literature as well as participant responses. Math anxiety is a complex issue and can affect students for different reasons and in different ways. A consequence of math anxiety is the false relationship that students manifest when they believe that their performance is solely based on their math competence. Students do not often factor in the relationship between math anxiety and math performance, and this can shape a student’s belief about their own math competence. Participants discussed how math anxiety makes students feel frozen and often results in an inability to complete work because students believe they “can’t do it”. The key here is that students believe they cannot do it, which leads them to not being able to do it.

Apart from the notable consequences of math anxiety, it is also interesting to analyze gender differences in math anxiety. Research has found that girls exhibit more math anxiety than boys (Hembree, 1990) but both participants claimed that math anxiety is present in both girls and boys. Participants described how math anxiety may manifest differently in the genders but did not disregard its existence in both. This disparity between research and participant interviews was interesting and will be discussed further in this chapter. The gender of the math teacher also seems to impact a student’s experience of math anxiety. Research suggests that female teachers exhibit more math anxiety than male teachers and can more readily transfer that onto their female students (Beilock et al, 2014). Participants had contradictory responses regarding this issue. One participant felt like the teacher’s content knowledge and confidence was a key determinant in their students’ experience of math anxiety. Interestingly, the other participant said they noticed gender differences in the form of male teachers exhibiting “bully” like behaviour and only excelling at teaching excellent students in math. The issue of gender is an interesting one and the implications of these findings will be further discussed in this chapter.
Additionally, parental influence can impact a students’ experience of math anxiety. Through language, behaviour and attitudes, parents can either transfer their own anxiety onto their children or instill anxiety due to high expectations. Teacher’s own experiences regarding math anxiety also plays a role in their teaching pedagogy which ultimately will impact a students’ experience of math anxiety in the classroom. Both participants recalled particularly traumatizing experiences when it came to math anxiety that then positively influenced their teaching pedagogy. Effective teaching pedagogy was also discussed in this chapter and various suggestions from the participants aligned with the research in this area. For example, collaborative work and forming personal relationships were themes present in both the interviews and the research. These findings are crucial when it comes to determining how to instructionally respond to students’ experience of math anxiety because it unpacks the teacher’s perspective. Teachers are aware that math anxiety exists and the participants in this study have plentiful experiences in and out of the classroom that make them committed to battling math anxiety.

5.2 Implications

In the school subject hierarchy, there is no debate that mathematics is ranked high, if not the highest. The importance of mathematics can often transcend into the post-secondary environment as well as in society as a whole. Due to this, it is crucial that the phenomenon of math anxiety be addressed in the fullest capacity. Math anxiety needs to be understood by teachers, parents and students in order for teachers to better instructionally respond to students’ experience of math anxiety. Whether we are aware of it or not, math anxiety can often be a barrier to math competence, confidence and ultimately success. My research implies that if math
anxiety is not a problem people are concerned with, it will continue to perpetuate in our school system and produce adults who will continue to carry their math anxiety with them and transfer it onto others.

5.2.1 Broad Implications

There is a connection between the educational community of administration, pre-service teacher instructors and even parents when it comes to math anxiety. All these stakeholders play an important role in how mathematics education is taught and what value it can bring to a student. Although these stakeholders do not directly interact with a student and their math education, they are not relieved of the responsibility of advocating for students who experience math anxiety in the classroom. Administration quite often cultivates a certain culture for a school community they are a part of. My research findings indicated that math positive language and the willingness to make mistakes contribute to lower math anxiety. Students often internalize attitudes and behaviours of the significant adults around them, and if the principal in their school outwardly expresses an appreciation for math, they might too.

Along with math positive language, another contributing factor of lower math anxiety is if students have a teacher who also model a strong knowledge base for math and the willingness to learn. This stems from pre-service teacher education in which teacher candidates are exposed to math teaching pedagogy more than actual math content. One participant in my research claimed that one of the most important things a teacher can do is have strong math content knowledge. Teachers cannot exhibit confidence in teaching a subject if they are not confident with the material themselves. This lack of confidence is often transparent to students and can influence their experience of math anxiety. Therefore, pre-service teacher education is a foundational part of producing confident math teachers and consequently, confident students.
Although administration and teachers influence a child, parents are probably the biggest influence in a child’s upbringing and can impact a child’s attitude about school depending on the value it is given at home. Predictably, parental attitudes, behaviours and language about math also impact their child’s perception of the subject. Due to the fact that math anxiety tends to perpetuate and become a “norm” in some adults, many parents will readily claim that they are just “bad at math” in front of their children. This language can be extremely harmful to a student’s perception of their own math ability because they may slowly internalize that being “bad at math” is acceptable. Through my interviews, participants described the crucial role that parents play in a student’s math education. Parents can be committed to providing a math positive space at home with access to math games and activities regardless of their own comfort with math. Parents may also be strong in math and impose unrealistic expectations on their children which can then lead to math anxiety. One participant memorably stated how easy it is for people to say “I can’t do math” but almost unacceptable to say “I can’t read”. The binary that has been socially constructed between math and literacy can often discourage students from pursuing math in secondary and post-secondary schools. The ease at which people accept math illiteracy is dangerous because it contributes to the perpetuating cycle of math anxiety. Until these stakeholders advocate for the issue of math anxiety and are firmly committed to battling it, it will continue to infiltrate classrooms.

5.2.2 Narrow Implications

Teachers may have the most vital role in the cycle of math anxiety. They are often the one that is with students when math anxiety is triggered and starts to interfere with academic success. My research findings focus on how teachers can instructionally respond to a student’s experience of math anxiety. It is evident that a teacher is required to do more than just respond,
and also can combat math anxiety by proactively creating a classroom climate that is inclusive and safe. Through my interviews, I discovered that both my participants try their best to proactively debilitate math anxiety by fostering a sense of community in the classroom. This is especially important at the elementary level since students spend most of their time in a specific classroom with the same peers. The participant who teaches in the elementary level described how they dedicate a few weeks at the beginning of the year to building community in order to create a safe space where learning can be attained.

Throughout my research and interviews there were many specific teaching strategies that aligned with lower math anxiety. Collaborative work with a focus on problem solving is a current trend that is especially common in the elementary level. It helps students problem solve while working with their peers. Individual conferencing with students is important at all levels as it allows for teachers to gain knowledge about specific student needs. Additionally, it often addresses concerns of students on a personal level where they may be more comfortable raising questions or concerns. One participant described that her teaching philosophy is grounded in making sure her students know she genuinely cares about them. She is devoted to hearing each student voice and vows to never let a student feel singled out in her math class because confidence is also related to math anxiety and academic success.

The types of math activities teachers assign students can heavily influence the onset of math anxiety. As previously mentioned, problem solving in the math classroom engages students in more meaningful learning because it often requires a deeper understanding of math. Research also suggests that authentic assessment tasks that students can relate to can enhance learning and once again reduce math anxiety. The key to all these math activities is to focus on student engagement in the math class. Math engagement correlates with the attitude students develop
about math which relates to math anxiety. Naturally, it is best practice to have students engaged in any classroom, but it is especially important in a subject like math because it is ranked high on the school subject hierarchy. Finally, research acknowledges that because a teacher plays such a vital role in instructionally responding to students’ experience of math anxiety, they also need to maintain their math content knowledge so they exude a certain level of confidence and competence in the class. Both participants agree that a teacher’s content knowledge is crucial in establishing credibility with students which will then influence their experience in the math class.

5.3 Recommendations

The cycle of math anxiety is complex. Societal attitudes around math tend to revolve around how important it is, but how difficult it is. It is held at a high standard, and because of this, math anxiety seems somewhat engrained in our schools. In order to effectively instructionally respond to students’ experience of math anxiety, teachers need to advocate for attainable success in math. Societal views tend to see math capability on a binary; either you are good at it or you are not. The first recommendation I am posing to responding to students’ experience of math anxiety is to cultivate a culture of appreciation, positive language and confidence when it comes to math. Math anxiety is detrimental to student learning and academic success; it continues to effect many people outside of school settings and into their adult life. It can be viewed as systemic and an accepted part of institutionalized education, but the cycle can be broken if all stakeholders take an active part in it. Removing language such as “I’m just bad at math” seems miniscule, but if over generalized negative statements such as that are abolished from homes and schools, math anxiety can slowly be terminated.

Apart from language and over all attitudes, math anxiety needs to be targeted early in students. With advocacy, also comes awareness. Students and teachers should not refrain from
talking about math anxiety and the impact it can have on student success. Another aspect of targeting math anxiety early, is fostering a sense of community in the classroom where students feel safe to raise concerns when it comes to math. Building personal relationships with students is essential in teaching, and especially crucial when it comes to deconstructing students’ attitudes about math.

Attitudes about math often correlate with student engagement in math. Research has shown that there is a relationship between math engagement, math competence and math anxiety (Hembree, 1990). Although a complex one, it is essential to address math engagement and math competence in order to tackle math anxiety. Current teaching pedagogy, especially in the elementary level, emphasizes the use of more student-centred learning, authentic assessment tasks, collaborative work and rich problem solving. It is more difficult to instill these practices daily in a secondary level due to time restrictions and more intricate math processes. Any math class can become more engaging if students can see that aspects of what they are learning in math is relevant to their life. Additionally, using cross-curricular assessment tasks such as math that integrates art and music in the classroom can also increase student engagement. Pursuing more cross-curricular connections in math can lead to the use of math journals where students can reflect on their math experiences in have also been shown to reduce math anxiety. These non-traditional teaching practices can enhance math class for all students, and help teachers instructionally respond to students’ experience of math anxiety.

5.4 Areas for Further Research

Throughout the span of this research project, math anxiety has revealed itself as a complex phenomenon. Throughout the literature review, many trends were uncovered regarding math anxiety. Most notably, the gender differences that appear in the math anxiety literature
seem to have a withstanding impact that spans in adult life. Research findings continuously suggested that girls experience more math anxiety than boys and female teachers exhibit more math anxiety than male teachers. The research participants in this study seem to disagree with these findings claiming that they do not notice a large gender difference in math anxiety, but rather how it manifests differently in girls and boys. The questions of gender differences in math anxiety is one that needs more rigorous research that would be more telling if it included actual students rather than second hand sources. Additionally, the research participants disagreed with research claims that female teachers have more math anxiety than male teachers. One teacher shared that the research might look this way because there are significantly more female elementary teachers than male and therefore it is not an accurate depiction.

Future research could look at the trend of math anxiety in pre-service teachers and how this manifests over time in a longitudinal study. Math anxiety in teachers often stems from a lack of content knowledge which suggests that pre-service teacher training does not sufficiently prepare teachers to teach math at a deep level. This also reflects the structure of the school system in which elementary teachers are required to have a knowledge base of a multitude of subjects and are expected to teach them all with the same level of confidence and ability, which is unrealistic. Another recommendation from a more structural perspective, is to explore the option of Grade 7 and 8 teachers having a subject specialization and only teaching that subject. The math in these 2 grades is foundational for math taught at the secondary level. In the current system, students are often not prepared for secondary math which can easily lead them to be streamed to a lower academic strand. In terms of research then, it would be crucial to determine if students in junior high school with specialized math teachers experience less math anxiety than
students in a regular elementary school. This study could be extended to observe how these students progress in secondary school, post-secondary school and in the workforce.

5.5 Concluding Comments

It is problematic that pre-service teachers who are adults with post-secondary education, still get overly anxious when asked to write a math test. My research topic became evident to me when other pre-service teachers in my cohort expressed genuine fear and anxiety before a preliminary math assessment. To me, the language and behaviour that I witnessed was inexcusable. Most elementary teachers have to teach math at some point and it was worrisome to me that people so incredibly anxious were responsible for other people’s math education. Throughout my research, I have delved into math anxiety and am more certain than ever about the societal impact this issue has. Students who experience math anxiety do not just “get over it”. It continues to affect them in secondary school and can deter them from applying to post-secondary programs that require math. It produces an underrepresentation of women in STEM programs and careers and finally, it produces qualified but math anxious teachers.

The onset, manifestation and sustainability of math anxiety is complex. The layers that contribute to why math anxiety exist and how it can be pervasive throughout a students’ schooling are interconnected. Through research and interviews it is clear that math anxiety can occur due to multiple reasons some of which may be due to the attitudes and behaviours of parents and teachers. Math anxiety may also ensue due to a lack of math engagement, negative math attitudes and students attributing failure to math competence as opposed to math anxiety. Teachers can effectively instructionally respond to students’ experience of math anxiety if they are committed to establishing a community in the class, target math anxious students early and
use more innovative teaching practices in their math class. These practices include but are not limited to rich problem solving that encourages collaborative group work, authentic assessment tasks that are relevant to students’ lives, activities that assist with math engagement such as games and cross-curricular tasks and finally awareness of their own math content knowledge and a commitment to professional development.

Teachers need to be committed to battling math anxiety. Teachers who are aware of the detrimental effects of math anxiety can better prepare themselves to instructionally respond to students’ experience of math anxiety. Teachers can be the guiding light to a child who never felt like they could do math. Teachers can convert a child’s language from “I can’t do math” to “I’m going to try my best”. This issue will not go away if educators do not advocate for it. Math anxiety will continue to infiltrate schools and produce math anxious people who will then transfer their anxiety onto others. It is a perpetuating cycle that needs to be broken where it starts: in the classroom.
References


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Appendix A: Letter of Consent for Interview

Date: ________________

Dear ________________,

I am a graduate student at OISE, University of Toronto, and am currently enrolled as a Master of Teaching candidate. I am studying how teachers instructionally respond to students’ experience of math anxiety. More specifically, I am interested in learning teachers’ perspectives and practices when it comes to math anxiety in girls. I am completing this research for the purposes of investigating an educational topic as a major assignment for our program. I think that your knowledge and experience will provide insights into this topic.

I am writing a report on this study as a requirement of the Master of Teaching Program. My course instructor who is providing support for the process this year is Dr. Eloise Tan. The purpose of this requirement is to allow us to become familiar with a variety of ways to do research. My data collection consists of a 45-60 minute interview that will be audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient to you.

The contents of this interview will be used for my assignment, which will include a final paper, as well as informal presentations to my classmates and/or potentially at a conference or publication. I will not use your name or anything else that might identify you in my written work, oral presentations, or publications. This information remains confidential. The only people who will have access to my assignment work will be my research supervisor and my course instructor. You are free to change your mind at any time, and to withdraw even after you have consented to participate. You may decline to answer any specific questions. I will destroy the audio recording after the paper has been presented and/or published which may take up to five years after the data has been collected. There are no known risks or benefits to you for assisting in the project, and I will share with you a copy of my notes to ensure accuracy.

Please sign the attached form, if you agree to be interviewed. The second copy is for your records. Thank you very much for your help.

Sincerely,

Kimberly D’Cunha
Phone number, email: ______________________________

Instructor’s Name: ________________________________
Phone number: ______________________ Email: ______________________

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 at any time without penalty.

I have read the letter provided to me by Kimberly D'Cunha and agree to participate in an interview for the purposes described. I agree to having the interview audio-recorded.

Signature: ________________________________

Name (printed): ________________________________

Date: ______________________
Appendix B: Interview questions

First of all, I would like to sincerely thank you for participating in this interview. The aim of this research is to learn how teachers instructionally respond to students’ experience of math anxiety. More specifically, I am interested in learning about teachers’ perspectives and practices when it comes to math anxiety in girls. The interview should take approximately 45-60 minutes and it will be in 4 sections. This will include Background information, Teacher practices, Beliefs and Values, Influencing factors, and Next Steps. I will ask you a series of questions focused on the causes, signs and consequences of math anxiety. I want to remind you of your right to choose not to answer any question…Do you have any questions before we begin?

Background Information

- Describe your overall teaching experience.
- Describe your overall math teaching experience.
  - What do you teach? (grades/subjects)
  - Where do you teach? Can you please tell me a bit more about your school? (e.g. size, demographics, program priorities)
  - How many years have you worked as a teacher? How many years have you been teaching at this school?
  - What personal, professional, and educational experiences informed your interest in math education and prepared you to respond to students’ experience of math anxiety?
    - Probe: teachers college, own experience of math anxiety, teachable subjects, AQs, undergraduate work.
    - Did you personally experience math anxiety as a student? If yes, what was that experience like? What effects did it have on you?

Beliefs and Values

- What does math anxiety mean to you? In your experience, how common is it?
- What do you think is the most important thing students can take away from learning and feeling successful in math and why?
- What indicators of math anxiety do you look for/see from students? What signs and symptoms of math anxiety are noticeable in the classroom?
  - In what ways, if any, do these indicators manifest differently for boys and girls? Please give some examples.
  - In your experience, do you believe that one gender is more likely to experience math anxiety? If yes, which one and why? If no, why?
Have you observed differences in math engagement? If yes, what have you observed?

Have you observed differences in math performance? If yes, what have you observed?

- How, if at all, do you think the gender of the math teacher contributes to students’ attitude toward math?

- What factors do you think contribute to math anxiety in students?

- Have you noticed that students’ experience of math anxiety manifests differently across grade levels? If yes, how? If no, why do you think that is?

- In your view, what are some of the potential outcomes from students’ experience of math anxiety?

- In your experience, what do you believe are some effective teaching strategies and tools that can be used to combat math anxiety and why?

- How do you think parent interactions influence attitudes about math in and out of the classroom?

Teacher Practices

- Can you tell me a bit more about your approach to teaching math, generally speaking?
  - How would you describe your approach and preferred instructional strategies?
  - What are the different forms of assessment you use in your math class and why?
  - How, if at all, do you think these affect math performance, math anxiety and attitudes towards math?

- How do you respond to students’ experience of math anxiety?
  - What are some of the instructional strategies and approaches that you use and why?
  - Do you enact different strategies for boys versus girls? If yes, how is your response different and why?
  - How do students respond to these? What outcomes do you observe from them?
  - What resources support you in this work?

- Can you give me an example of how you have responded to a students’ experience of math anxiety?
  - Who was this student? (grade)
  - What were your learning goals for them?
What instructional strategies did you enact? What opportunities for learning do you create? What resources, if any, did you use?

How did your student respond?

Influencing Factors

- What have been some of your greatest inspirations as a math teacher? How do you want your students to remember their experience of math in your classroom?

- What challenges do you encounter in responding to students’ experience of math anxiety? How do you respond to these challenges? What would help you respond to these challenges?

Next Steps

- What are some of your favourite resources that you would recommend to new teachers to respond to students’ experience of math anxiety?

- What advice, if any, do you have for beginning teachers who are committed to instructionally responding to students’ experience of math anxiety?

- Thank you for your time and participation.