Demystifying Math Anxiety: Exploring Teacher Perceptions of Math Anxiety on the Teaching-Learning Process

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Abstract

This study focuses on teacher perception of math anxiety on the teaching-learning process. How do teachers perceive math anxiety and its effects on their students? How do teachers perceive math anxiety and its effects on themselves? The purpose of this study is to "demystify" math anxiety by exploring how in-practice teachers perceive this issue so we can better understand math anxiety and improve math education for our students. In particular, this study honed in on what strategies teachers have used in their experience with teaching math to students with math anxiety to provide practical takeaways for pre-service teachers. The participants were two primary-junior teachers in the Greater Toronto Area who have taught for at least 10 years and have taught math among other subjects. The findings suggest teachers perceive math anxiety to negatively impact student leaning and teacher efficacy. In addition, the data also suggest there to be a direct correlation between teacher experience and background and teacher perception of math anxiety. The strategies mentioned in this study to help alleviate student math anxiety revolved around having a caring, encouraging teacher at the centre with technology being credited for helping generate engagement and interest. Both the literature and findings appear to indicate a significant link between a teacher's own experience with mathematics and their perceptions, hence, this study concludes with recommendations to the educational community to provide more resources for teacher preparation for teaching mathematics in order to improve teacher comfort levels and as a result, teacher efficacy and the overall quality of math education for our students.

Keywords: mathematics, math anxiety, teacher education, teacher perceptions, math education, primary junior, teaching learning process
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Chapter 1: Introduction

Research Problem Statement

Mathematics is often at the forefront of policy debates, indicating the public's consistent interest and value in this core subject. Most recently in December 2013, ministers of education across Canada are prioritized improvement in the math curriculum and math education after results from the Organisation for Economic Co-Operation and Development's Programme for International Student Assessment displayed an alarming trend across the board of Canadian students (15 years old) failing the math test portion (Morrow, Globe and Mail, 2013).

The prioritization of mathematics in education brings to surface an important question: What or who affects students' mathematical performances? Research in math anxiety and 'mathphobia' has been ample in the area of student focus; what may cause student math anxiety and how educators can help alleviate student math anxiety. However, in comparison, not as much research has been conducted in the area of math anxiety in teachers.

A few recent studies have begun to link teacher math anxiety with students' academic performances. In Sian Beilock's (et al.) study published in 2010, findings demonstrated a possible correlation between teacher math anxiety and student performances by affecting students' gender ability beliefs; having a highly anxious female math teacher resulted in lower academic achievements in female students.

As the helmsman of a classroom, the ability, comfort-level and confidence of a teacher in teaching a particular subject could directly impact the quality of student education and their subsequent academic performance.
Background of the Researcher

As a teacher candidate, I personally identify with being math anxious. I remember speaking with other teacher candidates before our first math class about how nervous we all were; most of us came from a liberal arts or humanities background with little to no experience in mathematics after high school. My undergraduate degree was in Asia-Pacific Studies and Political Science; the last time I remotely "did math" was in grade 11. At that point, it dawned on me that as primary-elementary trained teachers, we would all be expected to be able to teach math from the kindergarten to grade 6 level when we eventually enter the profession, regardless of whether or not we feel comfortable. As a pre-service elementary teacher, I am very interested in exploring what are some avenues or strategies that teachers have used to successfully overcome initial math anxiety and share this knowledge with my fellow math anxious colleagues.

Purpose of this Study

As mentioned previously, academic research in math anxiety tends to revolve around the student voice or how to "make it better" for the students directly. Math anxiety is not something exclusive to students; teachers and teacher candidates can also self-identify as being math anxious yet are still expected to teach that subject. The purpose of this study is to lend a voice to those teachers who self-identify as being math anxious and explore the multitude of strategies, adaptations and methods that they use in order to adapt to teaching math. Through the scope of this study, I hope to gain more insight regarding mathphobia from the perspective of teachers and share the findings with other math anxious teacher candidates who may be entering the field with initial discomfort about the idea of teaching math.
Central Question and Sub Questions

My central research question for this study is: What are teachers' perceptions of the role math anxiety plays in the teaching/learning process?

The following sub-questions will support the principle question:

1. What teaching strategies do teachers feel help alleviate math anxiety in students?

2. How do teachers feel math anxiety in educators impact their teaching practices?
Chapter 2: Literature Review

For the purpose of this study, the literature review will be organized into the following sections: definition of math anxiety, math anxiety in teachers, math anxiety in elementary students and teaching strategies for math anxiety.

Definition of Math Anxiety

Defining 'math anxiety' is complex. The term was first coined as "number anxiety" by Dreger and Aiken in 1957. Their research concluded that math anxiety was separate of general anxiety and was independent of general intelligence. The authors concluded that math anxiety was "emotional disturbance in the presence of mathematics" (Dreger & Aiken, 1957, pg.344). However, there is not one conclusive, all-encompassing definition of the term 'math anxiety'. Scholars primarily align into two opposing camps: on the one hand, some define math anxiety as "the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem" - in other words, focusing the definition on the emotional impact of the individual. On the other hand, some scholars prefer a more pragmatic definition that focuses on the actual effects on mathematical performance: math anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situation (Wood, 1988, pg.8). Eric Wood argued that although the definition of math anxiety is inconclusive, the issue still deserved to be investigated simply because many people do have a negative connotation regarding mathematics. In his article, Wood opted to use the term math anxiety as "a way of talking about the general lack of comfort that someone might experience
when required to perform mathematically, and the ramifications of such a disposition in an elementary teacher." (Wood, 1988, pg.11).

As seen from the variety of characteristics above, there is hardly a single, concise, perfect definition to math anxiety. This inconclusiveness should not stop us from investigating this matter as the negative connotation and importance placed on this school subject is very much real and imminent. For the sake of this study, the author has opted to adopt a mixed definition where math anxiety is regarded as discomfort regarding matters having to do with mathematics, the results can be emotionally intrinsic and/or affecting mathematical performance.

**Math Anxiety in Teachers**

There appears to be a congregated focus regarding math anxiety in pre-service teachers. One author, Ray Hembree, suggests that pre-service elementary teachers are especially susceptible to math anxiety (Hembree, 1990, pg.33). This view is supported by other scholars (Gresham, 2007; Dunkle 2010) who have found correlations between math anxiety and pre-service teacher education. In particular, Gina Gresham conducted a study in which math anxious teachers demonstrated significant math anxiety reduction after completing a mathematics methods course, something that is not mandatory in teacher education, despite its positive effects. Susan Dunkle's research supports Gresham's findings as her dissertation suggest math anxious students tend to develop lower self-esteem, which may result in a self-fulfilling prophecy of academic failure. Math teachers themselves were once students and if they identified with math anxiety then, this sense of low self-esteem may carry forth to their teaching profession and practice (Dunkle, 2010, pg.54). "Understanding mathematical content and its presentation will help pre-service teachers teach their students effectively, thus preventing or reducing mathematics anxiety in their future students." (Gresham, 2007, pg.187). This view is shared and
supported by Sloan (2010) who suggested that pre-service teachers be screened for math anxiety and to make it mandatory for pre-service teachers to take a math methods course.

Other statistics support this view of the impact of teacher math anxiety on teacher practice. From 1983 statistics, teachers who do not feel comfortable teaching math spend about fifty percent less time teaching that subject than teachers who do feel comfortable (Sloan, 2010). Math anxious teachers also rely more on teaching with algorithms while neglecting cognitive thought processes and reasoning. What this may imply is that math anxiety in teachers is a perpetuating, spiraling problem and pre-service elementary teachers are more susceptible to math anxiety (Hembree 1990) when they are not properly prepared in teacher education (Gresham, 2007). As a result of unpreparedness, it could lead to lower self-esteem (Dunkle, 2010), translating to an effect of poor classroom instruction.

One of the most prominent effects of teacher math anxiety is its negative impact on teaching practice. Scholars such as Margaret Walshaw argues that teacher knowledge is at the core of effective teaching.

Lying at the heart of effective teaching are the knowledge and skill that an individual teacher brings to the cognitive demands of teaching. What teachers do in classrooms is very much dependent on what they know and believe about mathematics and on what they understand about the teaching and learning of mathematics...successful teachers are those with both the intention and the effect to assist students to make sense of. (Walshaw, 2012, pg. 181)

In other words, math anxious teachers who do not feel confident in their knowledge of mathematics may not be able to deliver effective, engaging lessons due to their lack of knowledge and confidence.

**Math Anxiety in Elementary Students**

Recent research has started to focus on math anxiety in younger students, primarily in elementary school, shifting the emphasis away from on adolescents and adults. Young et al.
conducted a MRI study in 2012 on seven-to-nine year old students with math anxiety. The team developed the Scale for Early Mathematics Anxiety (SEMA) and found that students with high levels of math anxiety exhibited hyperactivity in the area of the brain associated with negative emotions and hyperactivity in areas of the brain associated with mathematical reasoning. This study, which has been referred to by other authors in the field (Jameson, 2014; Ramirez et al., 2013), is significant because it brings to surface the impact of math anxiety on young children and their mathematical reasoning.

Another researcher who recognized the gap in academic research on math anxiety around young children is Jameson (2014) who conducted a study on contextual factors of math anxiety in grade 2 children. Her findings indicated that math self-concept was the strongest predictor of math anxiety in second grade children. Jameson defined math self-concept as "a person’s perceptions of him- or herself, is a multifaceted and hierarchical construct that includes general self-concept as well as self-concepts of more specific subareas, such as mathematics." (Jameson, 2014, pg.521) This study supports the existence of math anxiety in young children, prompting for more research to be done on this understudied population, much like Young et al.'s study. Jameson's study does lack performance data, hence no conclusion or link can be made between math anxiety and actual student math performance at this age group.

Ramirez et al.'s (2013) article continues where Young and Jameson left off in terms of exploring the implications of math anxiety on young students rather than just focusing on supporting the existence of the problem. Ramirez et. al's study finds a negative relation between math anxiety and math achievement for children with high working memory because their working memory capacity is co-opted by math anxiety. The authors argue that it is absolutely imperative for early identification and treatment of math anxiety because otherwise, students
with the most potential, the ones with high working memory, will avoid math courses and math-related career choices in the future.

**Strategies for Math Anxiety**

How can the effects of math anxiety be alleviated? Jansen et al.’s (2012) study suggests that success in math leads to more practice in math and hence, higher math performance. This finding is also shared by Finlayson’s study conducted in 2014, which included surveying 70 pre-service teachers on their perceptions of causes of math anxiety and teaching strategies to help alleviate the issue. The top three strategies identified by the pre-service teachers included: diverse teaching strategies, slower pace and encourage risk taking. The participants indicated the importance of diverse teaching strategies to create a constructivist learning environment "where there is a spirit of inquiry, trust and expectation, reduces math anxiety." (pg. 111) Lessons should be engaging, encourage students to ask questions and collaborative learning.

Many students spoke of the importance of having teachers believe in them, and tell them that they could do the mathematics, and celebrate the small successes of students. They indicated that teachers who were approachable and who took an interest in their students played an important part in relieving math anxiety. (Finlayson, pg. 112)

The implication of this study is that all the participants identified the importance of the role of the educator in the classroom in regards to math anxiety. Finlayson’s article supports the purpose of this research because there is merit to exploring teacher strategies and perceptions on math anxiety as the educator’s role is clearly very significant in the classroom and in particular, dealing with math anxiety.

As classrooms and schools become more and more technologically equipped, educators have been starting to incorporate technology in their teaching, especially in math, with most
results reporting a positive effect. A class in a Baton Rouge school started using tablets in the classroom and as a result, test scores have improved since this implementation.

The ability to create an interactive lesson each day is amazing, says Beal [a teacher]. It is almost like a one-to-one environment for each student, because of the interaction between my tablet and their tablet, but at the same time it is cooperative learning amongst the students because they can all participate and work together too. (Zuger, 2008, pg. 14)

Other studies and reports share similar findings that the use of technology in teaching math in the classroom have resulted in better student engagement and performances. (Bouta & Retalis, 2012; Franklin & Peng, 2008) However, the main focus of these studies are quantitative and only emphasize on improving student achievements in mathematics, relaying very little to how the teacher feels in regards to using these technologies in their classroom. The only reference to the teacher perspective was from Franklin and Peng's study in which student learning was supplemented with the use of iPod touches in math class. One teacher was quoted, "It was amazing how they just jumped in and helped their classmates when they were having technology difficulties. It was neat to watch students demo their creative shows in math class..." (Franklin & Peng, 2008, pg. 77) It can only be implied that the positive effect of incorporating technology into their classroom instruction, which resulted in concrete student improvement, also translated to increased comfort and confidence level in the instructor, never explicitly explored in the quantitative studies. The gap in literature affording a voice to the teacher drives the focus and purpose of this study.

Both Finlayson (2014) and Jansen (2012)'s research points to the educator as a key figure in combating math anxiety in the classroom. Often times, the educator's own comfort level with the subject is overlooked and can directly affect their instructional effectiveness, as discussed in the section of teacher math anxiety. Interestingly, some research has shown a positive results for using technology in pre-service teacher education to help with teacher math anxiety. Irene
Plonczak’s study on videoconferencing in Math and Science Preservice Elementary Teachers’ Field Placements (2010) marries both the use of technology and the focus on pre-service teachers to tackle math anxiety. Her study found that by teaching math lessons during their placements through videoconferencing, it highlighted the strengths and weaknesses of questioning skills and also allowed pre-service teachers to become aware of their limited content knowledge.

The pre-service teachers in our study saw that they had to know their content well and anticipate where students may have gaps in their understanding. By not having a good grasp of the subject matter our pre-service teachers resorted to using teacher centered instructional strategies. The issue at stake is not the nature of the remote character of videoconferencing but the lack of understanding of the content matter, and what is important in the context of videoconferencing, is that it allows pre-service teachers to look face to face into these limitations. (Plonczak, 2010, pg. 252)

In other words, this study suggests that the root to teacher math discomfort or anxiety goes back to pre-service training and using technology such as videoconferencing allow candidates to better acknowledge the greater problem of not knowing enough content material for the respective subjects. Expanding from the scope of using technology in the classroom to enhance mathematical teaching, this study supports using technology in teacher education to be proactive in tackling teacher math anxiety.

Why This Study

From the literature review above, it is evident that although the topic of math anxiety as been amply researched, most studies conducted have been quantitative in nature and focuses on alleviating math anxiety for students. Very little attention has been paid to teachers’ perceptions on the effects of math anxiety on the teaching learning process. This study will attempt to fill in this literature gap and lend a voice to teachers and allow its readers to see math anxiety from the eyes of an educator, examining its impact in the classroom, strategies used and its effects on both the teachers and the students.
Chapter 3: Methodology

This research project is a piece of qualitative research focusing on existing literature on math anxiety (Chapter 2: Literature Review) and in-person interviews with two Ontario Certified Teachers in the Greater Toronto Area. This chapter will outline the procedure for literature review, data collection, participants, data analysis, the ethical review and limitations.

Literature Review

The literature review was conducted prior to the interviews in an attempt to better understand the issues surrounding math anxiety and for the author to situate herself into the existing dialogue. The literature review was divided into four main sections: definition of math anxiety, cause and effect of math anxiety in teachers, the use of technology in the math classroom and the use of technology in teacher education. The majority of the resources used were scholarly journal articles or peer-reviewed articles in the education discipline.

Data Collection

Two teachers were selected from two schools in two different school boards in the Greater Toronto Area. Both teachers were the researcher's past associate teachers and have at least 10 years of teaching experience, particularly in the subject math. The participants were first contacted in person or by email to ask for permission and interest, and then an in-person interview time was scheduled. My data was collected in person and the interviews were captured on audio devices. Each of the interviews were approximately 30 minutes in duration. The audio recordings were used solely for the purpose of transcribing the interviews.

Here are some sample interview questions:
1. How long have you been teaching? What grades and subjects have you taught?

2. What is your experience with teaching mathematics?

3. What are some challenges you have encountered as a math teacher?

4. What are some challenges you have encountered as a math teacher?

5. What does "math anxiety" mean to you?

6. Do you have experience dealing with math anxious students? How did you know they were math anxious?

7. What strategies, if any, did you use to help these students?

8. According to yourself, were these strategies effective in helping alleviate the students' math anxiety? How effective?

8. Were any of these strategies technology-based? If so, please elaborate. If not, please explain why no technology-based strategies were used.

9. How comfortable would you say you are with mathematics, either as a teacher or as a student?

10. What advice would you give to pre-service math anxious teachers?

11. Do you find your own personal experiences or perceptions of mathematics as an influential factor to your teaching?

Participants

I interviewed two participants, both in-practice primary-junior teachers in the Greater Toronto Area. I selected these two participants because both had extensive teaching experience,
over 10 years, and they were from different school boards, which may potentially allow me to get a different perspective based on geographical location and board practice. Both participants have years of experience with teaching math to their homeroom classes and more importantly, one participant specialized in the junior grades while the other participant has had most of her teaching experience in the primary grades, offering me both perspectives in the primary-junior range.

My first participant is Kayla. She has been teaching in the York Region District School Board for 10 years now. Kayla had studied commerce for her undergraduate studies and described herself as "pretty comfortable" with math as a teacher and when she was a student. Kayla has taught a variety of grades from kindergarten to grade 6 but has spent the last few years teaching grade 2.

My second participant is Justin. Justin has been teaching in the Toronto District School Board for 13 years and has taught grades three through six. He has been teaching grade 6 for the last several years at an open concept school. Justin's undergraduate degree was in religion and has self-identified himself as having experienced math anxiety when he was a student.

Both participants were my previous associate teachers, which allowed me to be familiar with their background and experiences, an important aspect according to Dilley (2000), whose advice to new researchers is to familiarize themselves with their interviewee's backgrounds as to better understand the cultural context of the data.

Data Analysis

After I had recorded the interviews, I transcribed them by reading through the data multiple times to highlight key words or words and phrases that appeared repeatedly throughout
the interview. I used Creswell’s *Qualitative Inquiry and Research Design* as a point of reference for my data analysis. I created a chart to track the frequency of certain words and phrases (codes) and then I used the highlighted key words and phrases to help me develop themes by writing the individual codes onto sticky notes and visually categorizing them under broader themes. I copy and pasted direct quotations from the interview transcripts to support my codes and themes in a table format.

The main purpose of this research project is to shed light on the perceptions of math anxiety on the teaching-learning process and more importantly, to identify what strategies and advice two veteran educators provide from their rich teaching experiences to alleviate student math anxiety. My data was analyzed under the lens of identifying the impact of math anxiety and what the possible solutions could be.

**Ethical Review Procedure**

Prior to participation, all participants would be given a consent letter to read and sign; a copy would be given to the participant while one copy will be kept by the researcher (please refer to Appendix). In the case of phone or Skype interviews, participants will be emailed a copy of the consent letter and scan back a signed version to the researcher. The interviews will be conducted outside of school time. It will be made clear to the participants that the interviews will be recorded and transcribed and transcripts will be available for their approval and review prior to publication. All school names and participant names will be confidential. All participants will also have the right to withdraw from the study anytime up to the completion date of the study. Participants will be notified at the date of study completion and may request a published copy of the study.
Limitations

This research study is strictly qualitative, which has its drawbacks and limitations. The depth of interviews were limited by the ethics protocol as the researcher was only allowed to interview adults, eliminating student participation in this study. This is an important limitation as teacher math anxiety is often linked with student math anxiety and the limited scope of the interviews prevented the author from exploring this link.

Another limitation is the lack of quantitative data to back up the qualitative findings; any statistics and data would have to be taken from secondary sources or based strictly on the interviews. Basing analysis on personal anecdotes or accounts can limit the overall strength of the conclusion and the claim for any larger generalizations or trends as the sample of interviewees would be too small and personal. The geographical scope of interviewing teachers from only the Greater Toronto Area may also limit its applicability to other school boards and teaching professionals.

Strengths

Despite the limitations, qualitative research does have its strengths as well. The interviews allow the study to centre around teachers and educators when traditionally, the study of math anxiety tended to focus around students only. The personal narratives of the participants also shed light on the realistic strategies some educators have found useful to combating their math anxiety, which may help math anxious pre-service or new teachers. The anecdotal nature of the interviews allow the participants, the author and the readers to validate and make meaning of the participants' experiences. Often times, teaching can seem very removed from the field of research and reflection. The personal nature of qualitative research offers a reconciliation.
between the practicality of teaching in the field and taking part in educational research for professional development, training and self-reflection.
Chapter 4: Findings

In this chapter, I will discuss key themes and insights I notice from the data of the study. I have organized my coding into 4 main themes of: negative impact of math anxiety to students, teacher strategies to help math anxious students, teacher self-help strategies, and impact of math anxiety on teachers. The main themes were devised to help answer my main research question in probing a teacher's perception on math anxiety and its impact on the teaching-learning process, shedding light hopefully on what kinds of impact math anxiety lends and what strategies are useful. The subthemes have been organized to delve deeper into the specific impacts and strategies revolving around math anxiety from an educator's perspective and experiences.

Negative Impact of Math Anxiety on Students

Both participants implicitly and explicitly discussed the negative impact of math anxiety on student performance. Within the theme of negative impact of math anxiety to students are the subthemes of mental block, appearance of inability and hampering of perseverance.

Mental block. Both participants commented that one of the biggest negative impacts for students with math anxiety is the mental block the anxiety creates. The block skews the student's self-perception in their own math abilities and almost sets them up for failure from the start. One participant commented that the mental block the anxiety creates is akin to applying his or her own resistance to math, much like a self-fulfilling prophecy.

I think what it does is...it sort of hampers their perseverance with math. Because a lot of times they may tend to give up...much earlier than if they stick with it and try to work through...push through the difficulties and come to a point of understanding. So I think it will affect their level of perseverance. Or even just their ability... you know their belief in themselves to do math...which I think is influential...there's a wise saying...I think it was Confucius that said, "Whether a man thinks he can or he can't, he's usually correct." So
with math anxiety is the idea of I think I can't and therefore it's like a self fulfilling prophecy.

Another participant had likened math anxiety to be so mentally consuming for the student that he or she would be only focused on getting the "right answer", forgoing the explanation and using different strategies. The shared perception that math anxiety affects students mentally is also supported by Jameson (2013), who identified math self-concept as the strongest predictor of math anxiety in second grade children. How students see math and themselves appear to have actual resounding effects on their mathematical performances. A study conducted by Young et al. (2012) found from MRI scans that those who suffer from math anxiety experience a physical effect as the area of the brain associated with mathematical reasoning produces negative emotions and hyperactivity.

**Appearance of inability.** Another negative impact highlighted from the participant interviews is that math anxiety can often manifest itself into an appearance of math inability, in the sense that it makes the student look like they "just cannot do math". Dunkle (2010) also notes how, math anxiety can negatively impact a student's self-esteem, which may cause them to feel like they are unable to do the math.

One participant referred to a specific student she taught whose math anxiety made him look like he was unable to do the math. According to the interviewee, the student would shut down when he was asked to do simple arithmetic math, leading her to believe initially that it could be a learning disability. However, she later discovered that the student did not have a LD but rather, math anxiety, which made him so anxious he could not focus on the math work. This example brings to surface the importance for educators to learn and understand the different
forms that math anxiety could manifest itself into one's classroom and that the mere appearance of inability may not necessarily point to a learning disability and deserves further investigation.

**Teacher Strategies to Help Math Anxious Students**

Since math anxiety is viewed as a negative impacting factor on student learning from the extent of the interviews conducted for this study, this study also explores effective strategies to help math anxious students. The following section discusses different ways the participants assisted their students with mathematics anxiety.

**Technology.** Both participants concurred that the implementation of technology in their math programs was helpful. They felt that students were growing up in a technological era and by incorporating technology into math instills a kind of familiarity and novelty to the subject, which may help alleviate math anxiety.

One participant mentioned the use of electronic questions that students could complete on a website that gave instantaneous feedback without human pressure. The website would allow students to practice a concept and check their answers on the spot, and they would be allowed to go back to work on or correct that question for as long as they need. The participant reasoned that part of the benefits of using this piece of technology is that it takes the human element and "teacher-over-the-shoulder" pressure off the student and allows them to be engaged with the computer one-on-one for repetitive practice with instant feedback. This piece ties in with Zuger's (2008) study in which a teacher commented on how the incorporation of tablets in her classroom improved one-on-one interaction between teacher and student.

Another participant referred to the use of math games, Smart Boards and data projector to share student work. The participant mentioned how helpful the data projector is as she could use
it to show different student work samples and have the class discuss the many different strategies of approaching the same question, allowing students to see that math is not simply just about that "one right answer".

The technology uses mentioned by the participants all helped them diversify their own teaching strategies, which is in line with Finlayson's (2014) research that differentiated instruction is extremely important to helping tackle math anxiety.

**Creating sense of comfort.** Math anxiety causes a feeling of discomfort in students. Some strategies that came up during the interviews revolved around trying to calm the students down and to instill a sense of comfort in order to counteract the anxiety and stress.

One educator discussed different breathing exercises and taking the student for a quick walk around the school to refocus as strategies to calm the student down physically. Both participants mentioned the importance of small groupings as a key strategy for instilling a sense of comfort in math anxious students. Both participants highlighted the importance of working one-on-one with the student because in that smaller setting, the student would feel less stress to perform well in front of their peers. The small group conferencing would also allow the teacher to demonstrate to the student that there may be multiple ways to get to the correct answer and help them through with the explanation or ideas they may have in their heads.

An additional strategy that was discussed was the infusion of humour in math lessons. One participant felt it was beneficial to incorporate lessons that would help peak student interest in order to keep them engaged and almost "distract" them from their math anxiety. This also would assist with helping students feel more comfortable in math class. The participant recalled how students who regularly would "tune out" for math would perk up and smile and appear to
pay more attention when he used humour or stories in his math lessons. The participant also noted that the use of stories and humour to generate interest would also heighten student perseverance, leading students to increase their attempts at the math questions they previously quickly gave up on.

**Enthusiasm.** Both participants commented on their enjoyment of math and teaching math and they believed this interest was mirrored and reflected in their students. In a way, enthusiasm was regarded as an antidote to the stress and dreadful feeling caused by math anxiety.

For example, one participant who experienced math anxiety himself when he was student, commented on how he gets enthusiastic whenever he brings math into his classroom with other subjects (cross-curricular):

Sometimes I've brought math into art and brought math into science and with a certain enthusiasm just because of the fact that I just really like to see the underlying mathematical patterns. It really really helped me appreciate the concepts in the art and the science and you know in other subject area that I was teaching. And I think my enthusiasm...I think enthusiasm is always contagious. And so you know whatever enthusiasm you can bring to teaching, it infuses that content with energy that translates to the kids themselves.

The importance in a teacher's enthusiasm is supported by Finlayson's (2014) research in which it highlights the symbiotic relationship between the support and encouragement of a teacher in tandem to student successes in mathematics.

**Teacher Self-Help Strategies**

As math anxiety can affect both teachers and students, another focus of this research project is to explore strategies and advices for teachers who may be math anxious. This theme includes two subthemes: decomposing concepts and seeking support.
Decomposing concepts. Decomposing concepts came up as one of the strategies a math anxious teacher could try. It involved breaking down mathematical concepts to the "nuts and bolts" [breaking down into simple details and steps] in order to better understand the mechanics.

One participant who personally experienced math anxiety relayed his experience in terms of how going through teachers college and having to break down concepts in math made him more comfortable with the subject. For this participant, he felt that by breaking down the concepts, it not only helped him to explain to the students but also helped him better understand the concept himself.

Seeking support. Another subtheme of teacher self-help that was suggested by the participants was seeking support and resources available in the schools, whether that be your associate teacher [for teacher candidates] or teaching partners and even the students themselves. The overarching idea appears to be not attempting to tackle math anxiety on your own but rather, to surround yourself with support. One participant mentioned that when she was doing her practice teaching placement, she had a lot of trouble with teaching geometry because she was not a spatial person. She received help from her associate teacher and advocates looking for support in teaching difficult strands from the many resources that exist in schools, such as finding a teaching partner to co-teach and co-plan with or even learning from the students themselves.

Impacts of Math Anxiety on Teachers

The last main theme explored in this project is the impact of math anxiety on teachers. One participant, who experienced math anxiety personally, described it as a "blessing in disguise" while the other participant, who felt comfortable with math, described the impact as most likely negative and a deterrent from the subject. The interesting note to take away here is
how each participant's own experiences with math affected their perceptions in the impacts of math anxiety on teachers.

For this participant, he experienced math anxiety as a student and regarded it as a way for teachers to empathize with math anxious students as an understanding role model.

I would say that your math anxiety could be a blessing because it will help you to empathize with students that may be going through similar types of aversions to math, I suppose I feel like, you know having gone through it myself, I've been a little more sensitive to the fact that some people may not be on...you know where a lot of people feel they should be...and you could be sensitive to help them to feel like they want to do it.

The other participant, who never experienced math anxiety as a student, speculated that math anxiety would have a negative impact on teachers because it would act as a subject deterrent.

I always enjoyed math and I liked the challenge and math is one of my favourite subjects to teach too. And I love just seeing the creativity and the problem solving that the students have so...I think so. I think if I felt really anxious about it I probably would want to shy away from it.

The interviews shed light on the perceptions of current in-field educators on math anxiety and its effects on students, on teachers as well as the strategies these educators have tried. What is perhaps most surprising is how much of an influence each educator's own comfort level and experience with mathematics had on his or her own perceptions of math anxiety's impact on teachers. The interviewee who experienced math anxiety first hand regarded the issue from a more positive perspective as a possible way to help teachers empathize with math anxious students while the interviewee with no history of math anxiety speculated math anxiety to be strictly a negative influence on teachers. This finding perhaps alludes to the powerful link between teacher experience and teacher perception and how the former can have resounding effects on an educator's approach and outlook to teaching.
Chapter 5: Discussion

The purpose of this chapter is in three parts. The first part is to revisit the initial questions posed in Chapter 1 and discuss how the findings fit in with the current research. Secondly, we will explore implications and recommendations for practice. Lastly, we will look at the limitations and any questions for further research.

Teachers' Perceptions of the Role Math Anxiety Plays in The Teaching Learning Process

According to my participants, math anxiety, for the most part, had an overall negative impact on both the teacher and the student. In particular, they believed that math anxiety manifested itself by creating a mental block for the student, preventing him or her from persevering and believing in oneself. The mental block could also lead to the student appearing unable to do math, which negatively impacts a teacher in how to help that student. Is the student unable to do the math due to a genuine lack of abilities or learning difference or is it due to anxiety? The mental block that the participants attributed to math anxiety and its subsequent lack of perseverance and low self-confidence connects to Jameson's research in which math self-concept, a person's perception of him or herself in mathematics, was identified as the main predictor of math anxiety in second grade children (Jameson, 2014). The overall data highlighted how the effect of a mental block caused by math anxiety makes it difficult for an educator to initially determine which teaching strategies to use.

Strategies to Assist Students with Math Anxiety

The participants provided many strategies which fell under 4 main categories: generating interest, technology, creating a sense of comfort, and enthusiasm. All of the strategies mentioned share the commonality that the most effective strategies to combat math anxiety in students is to
help alleviate the anxiety by using a form of distraction, where that be using humour and storylines, the novelty of technology or simply a teacher's own enthusiasm in the subject.

Finlayson's research identified the significance of having encouraging teachers who celebrated student successes and took a personal interest in their students as having a positive effect in alleviating student math anxiety (Finlayson, 2014). This connects to the strategies provided by the participants which all involved a calm and caring educator at the centre of the different strategies who encouraged students through different avenues such as, the use of humour and storylines or through their own personal enthusiasm. The takeaway from this finding is that there is not just one correct strategy for all students. Every student, every class is different and there is a plethora of strategies out there for educators to try and use. In general, the strategies should help lessen the anxiety and induce interest or enthusiasm in the student.

Both participants had shared their own experiences with using technology as a strategy to help alleviate math anxiety, highlighting how the novelty of it helps generate student engagement and "distract" students from their anxiety. The success of using technology in math is supported by the research by Bouta and Retalis (2012), Franklin and Peng (2008), as well as Zuger (2008). All of the studies attributed increased student performance and engagement to the use of technology, a positive sentiment reflected by the participants' own experiences in their classrooms.

One interesting strategy that came out of the findings to help alleviate teacher math anxiety is to better one's own content knowledge through the means of either seeking support within the school system (co-teaching) or decomposing concepts. The importance of building and strengthening teacher knowledge is supported by literature such as Irene Plonczak (2010)'s study, which indicated that math anxiety in pre-service teachers has its roots in not knowing the
content material well enough. This point is further supported by scholar Margaret Walshaw (2012), who also identified teacher knowledge at the very core of effective teaching.

**Math Anxiety's Effect on Teachers**

The participants shared varying opinions on how teacher math anxiety affected an educator's teaching practices. The participant who had experienced math anxiety personally in the past regarded math anxiety on an educator as a "blessing in disguise" that allowed him to better empathize with students with math anxiety. On the other hand, the participant who had never personally experienced math anxiety extended her perception of math anxiety as having a negative impact on students to teachers as well. The significance of these two divergent opinions serves as a reminder how much an educator's own personal experience and background can affect his or her perceptions on education. Sloan's (2010) research indicated that teachers who did not feel comfortable with math spent about fifty percent less teaching time on math in comparison to their more comfortable counterparts. Both the data from this research project and the literature appear to indicate that there is a direct effect of math anxiety on teachers and teacher efficacy and that more research in the area of math anxiety's effect on teachers is deserving.

**Implications and Recommendations for Practice**

At the beginning of my research, my goal going in as a researcher and pre-service teacher was to "pick the brains" of some experienced educators as to what they thought about math anxiety and more importantly, useful strategies to help alleviate math anxiety in students. I expected to receive some very clear cut answers that would help my future practice as an elementary teacher who will have to teach math. Although the participants have been very
helpful in terms of sharing the strategies they have tried in their own practices, the overarching conclusion that came out of this research project is that the "answer" is anything but clear cut. Each participant had his or her own experience with math anxiety, own strategies, own successes and struggles. The only common thread that came out was both educator's commitment and openness to continuously try new strategies for their students and the shared perception that math anxiety is a source of deep impact on student learning and teacher efficacy. As a result, it is absolutely imperative we support educators and students by conducting more research around strategies to alleviate math anxiety.

Math anxiety can manifest itself in many different forms; each of our students is unique and special in their own right. As a future educator, this research project has informed me that there will never be one strategy that will work for all students. An effective teacher is one who never stops championing for her students, one who is responsive and differentiating, and one who never stops learning and researching his/her practice. My experience through this project allowed me to live the duo-roles of being both a researcher and teacher and how symbiotic these roles are. Effective teachers never stop developing themselves professionally for the sake of finding better, newer strategies for her students. Research helps better inform a teacher of the exciting new findings out there that could potentially be translated into her classroom to help her students with math anxiety.

Below are some recommendations to the educational community after careful consideration in both the findings and research discussed previously.

1. Mandatory mathematical content courses in teacher education programs
Both the research and participant interviews identified the importance of teacher content knowledge in the effective teaching of mathematics. By having preparatory courses focus on decomposing the topics and strands in the grade levels the pre-service teachers will have to teach in the future, students will become more familiar with the concepts and feel more comfortable teaching them. The courses should hone in on the most current teaching methods as expected in the curriculum (e.g., inquiry based learning) to prevent teachers from teaching "the way they were taught". It is imperative, based on my findings that course include some practical modules on how to teach/assist students with math anxiety.

2. Increase math teaching supports and resources in schools

One of the participants had identified her struggle with teaching geometry during one of her practice teaching placements and stated seeking help from her associate teacher. This luxury is no longer available once a teacher becomes certified. It would be very helpful to have more resources and collegial support, readily available to teachers in schools. For example, perhaps increasing the access to math resource team in schools or having more professional development workshops that focus on math come into schools to help support teachers.

3. Increase technology access in schools

The overwhelming research and participant experience supports the use of technology to teach math in order to increase engagement levels and allow students to receive instantaneous feedback without any stress. Increasing technology access in schools, whether that be through more funding for math software and/or game subscriptions or more funding for more devices and computers, there appears to be merit.
Limitations and Further Study

One of the limitations of this study is the small scope of participants. Although both participants are experienced, passionate educators, they only represent a very small cross-section of the countless excellent teachers we have in the field. Student and parent perspective are also absent from this study. What are students' perceptions on the role math anxiety plays on their learning process? What are parents' perceptions on the role math anxiety plays on their child's learning process? How does parent math anxiety influence their children’s attitudes towards mathematics? It would be very interesting to juxtapose the different perceptions among teacher, parent and student to see if there are any correlations across the perspectives.

Another area for further study would be how to structure math courses in teacher education programs. One of the key findings from this study is the importance of teacher content knowledge in helping educators feel more comfortable with teaching math. One of the participants referred to breaking down concepts to "nuts and bolts" while the literature reflects that in terms of good content knowledge being at the core of effective teaching (Walshaw, 2012). How then can we better prepare pre-service teachers with content knowledge? Should math courses be made mandatory for all teacher candidates? How should our pre-service math courses be structured? What would be the most effective?

Lastly, one very interesting learning that stemmed from this study is one of the participants, the one who experienced math anxiety himself personally when he was a student, noted that math anxiety could potentially be a "blessing in disguise" for a teacher to experience because it could help him better empathize with his students. This entire study focused on the negative impacts of math anxiety, from the participants' perspectives to the connections to
literature, but could there be an alternative perspective on math anxiety? Can teachers who experienced math anxiety better relate and empathize with their students? This is another interesting area certainly deserving of further investigation.

One of the most rewarding aspects of conducting research is the realization in how vast a topic like math anxiety can become. The more you research, the more you find, the more you will question and the more you will become curious to explore. Research is not about finding that one answer to math anxiety and then closing a door, but rather, finding some answers or sometimes, no answers, and then fuelling the curiosity to find more and opening more doors. I believe a good educator is one who is curious and persistent, one who never stops learning, simply for the sake of her students' learning.
References


Appendix A: The Consent Letter

Date: ________________

Dear ________________:

I am a graduate student at OISE, University of Toronto, and am currently enrolled as a Master of Teaching student. I am studying math anxiety for the purposes of a graduate research paper. I think that your knowledge and experience will provide insights into this topic.

I am writing a report on this topic as a requirement of the Master of Teaching Program. My course instructor who is providing support for this assignment this year is Dr. Mary Lynn Tessaro (marylynn.tessaro@utoronto.ca). This project's research supervisor is: Dr. Cathy Marks Krpan (cathy.marks.krpan@utoronto.ca). 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 30 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, outside of school time.

The contents of this interview will be used for my research project, which will include a final paper, as well as informal presentations to my classmates and/or potentially at a research 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 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.

Yours sincerely,
Mandy Lu

Principal Investigator

mandy.lu@mail.utoronto.ca
Consent Form

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw at any time without penalty.

I have read the letter provided to me by Mandy Lu and agree to participate in an interview for the purposes described.

Signature: _________________________________

Name (printed): _________________________________

Date:
Appendix B: Interview Questions

1. How long have you been teaching? What grades and subjects have you taught?

2. What is your experience with teaching mathematics?

3. What are some challenges you have encountered as a math teacher?

4. What are some challenges you have encountered as a math teacher?

5. What does "math anxiety" mean to you?

6. Do you have experience dealing with math anxious students? How did you know they were math anxious?

7. What strategies, if any, did you use to help these students?

8. According to yourself, were these strategies effective in helping alleviate the students' math anxiety? How effective?

8. Were any of these strategies technology-based? If so, please elaborate. If not, please explain why no technology-based strategies were used.

9. How comfortable would you say you are with mathematics, either as a teacher or as a student?

10. What advice would you give to pre-service math anxious teachers?

11. Do you find your own personal experiences or perceptions of mathematics as an influential factor to your teaching?