Conceptual Learning in Mathematics: How Number Talks Benefit Students with Math Anxiety

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A research paper submitted in conformity with the requirements
For the degree of Master of Teaching
Department of Curriculum, Teaching and Learning
Ontario Institute for Studies in Education of the University of Toronto

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Abstract

This Master of Teaching Research Project is a qualitative study focused on math anxiety that looks specifically at how number talks impact students with math anxiety. Math anxiety can be described as a feeling of nervousness and/or fear that prevents an individual from performing in math. The current literature on math anxiety shows how it is a problem that negatively impacts peoples’ self-esteem and ability in math throughout their lives. Limited research suggests strategies that teachers can use to support students with math anxiety such as adjusting teaching styles and making classrooms more inclusive spaces. While these strategies are beneficial, there is little information about specific practices teachers can use in the classroom to support math anxious students. With this in mind the main research question that guided this study is: How do a sample of Ontario elementary school teachers use number talks in their classroom and what outcomes do they observe from their students who are showing signs of math anxiety? To answer this question I collected information from three experienced primary math teachers. These teachers elaborated on what is currently found in the literature by describing the challenges and successes they have had with math anxious students during number talks. The information I have gathered from the interviews and literature indicates that math anxiety is a serious issue that needs attention.

Key Words: Math, Math Anxiety, Universal Design for Learning, Conceptual Understanding, Number Talks
Acknowledgments

I would like to thank my research professors Dr. Angela MacDonald-Vemic and Dr. Sarah Cashmore who helped guide me through the MTRP process and who were there for me anytime I needed extra help. Thank-you to the kind, caring members of Cohort 261 who were very supportive through this whole process. I also would like to thank my research participants who volunteered their time to talk to me; the experiences they have shared with me will have a lasting impact on my teaching. Lastly, I would like to thank my parents Tricia Leonard and Lindsay Webb, my siblings Madeline and Daniel Webb, and my boyfriend Ryan Herr who were all there to support me when I needed it the most.
## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>2</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>3</td>
</tr>
<tr>
<td>Chapter 1: Introduction</td>
<td>8</td>
</tr>
<tr>
<td>1.0 Introduction to the Research Study</td>
<td>8</td>
</tr>
<tr>
<td>1.1 Purpose of the Study</td>
<td>10</td>
</tr>
<tr>
<td>1.2 Research Problem</td>
<td>10</td>
</tr>
<tr>
<td>1.3 Research Questions</td>
<td>11</td>
</tr>
<tr>
<td>1.4 Background of Researcher</td>
<td>12</td>
</tr>
<tr>
<td>1.5 Overview</td>
<td>14</td>
</tr>
<tr>
<td>Chapter 2: Literature Review</td>
<td>15</td>
</tr>
<tr>
<td>2.0 Introduction</td>
<td>15</td>
</tr>
<tr>
<td>2.1 Indicators of Math Anxiety</td>
<td>15</td>
</tr>
<tr>
<td>2.2 The Causes of Math Anxiety</td>
<td>17</td>
</tr>
<tr>
<td>2.2.1 The impact of teaching styles on math anxiety</td>
<td>17</td>
</tr>
<tr>
<td>2.2.2 Math ability</td>
<td>19</td>
</tr>
<tr>
<td>2.2.3 Math anxiety and generalized anxiety disorders</td>
<td>20</td>
</tr>
<tr>
<td>2.3 Impact of Math Anxiety</td>
<td>21</td>
</tr>
<tr>
<td>2.3.1 Working memory</td>
<td>21</td>
</tr>
<tr>
<td>2.3.2 Motivation</td>
<td>22</td>
</tr>
<tr>
<td>2.4 Reinforcing Conceptual Understanding with Number Talks</td>
<td>23</td>
</tr>
<tr>
<td>2.4.1 Number talks</td>
<td>25</td>
</tr>
</tbody>
</table>
2.4.2 Number talks as a solution to math anxiety

2.4.3 Self-regulation, motivation and number talks

2.5 Conclusion

Chapter 3: Research Methodology

3.0 Introduction

3.1 Research Approach & Procedures

3.2 Instruments of Data Collection

3.3 Participants

3.3.1 Sampling criteria

3.3.2 Recruitment

3.3.3 Participant biographies

3.4 Data Analysis

3.5 Ethical Review Procedures

3.6 Methodological Limitations

3.7 Conclusion

Chapter 4: Research Findings

4.0 Introduction

4.1 Math Educators Recognize the Importance of Closely Observing Their Students Because Indicators of Math Anxiety Come in a Variety of Forms.

4.1.1 Math educators recognize that certain behavioral, verbal and emotional indicators of math anxiety can be very obvious.

4.1.2 Math educators recognize that certain behavioral, verbal and emotional indicators of math anxiety can be more subtle and difficult to detect.

4.1.3 Math educators recognize that indicators of math anxiety can arise in a variety of situations in the math classroom.

4.2 Math Educators Believe That Math Anxious Students Benefit from a Positive Classroom Environment Where They are Giving Individualized
Attention and the Opportunity to Learn Math in a Way that Increases Their Conceptual Understanding.

4.2.1 Math educators believe that focusing on conceptual understanding when teaching math is more beneficial to students with math anxiety.

4.2.2 Math educators found that conferencing and working one on one with math anxious students benefited their sense of confidence and ability in the classroom.

4.3 Even Though Number Talks are a School Board Initiative, Math Educators Also Include Them as a Part of Their Math Program Due to Positive Feedback From Students and Their Own Personal Pedagogical Positioning.

4.3.1 Math educators include number talks as part of their math program because they observe that students enjoy doing them.

4.3.2 Math educators use number talks in their classroom because they believe that they prevent math anxiety and benefit students who are experiencing math anxiety.

4.3.3 Math educators use number talks in their classroom because they align with their personal pedagogical beliefs and benefit their students’ learning.

4.4 Math Educators Face Challenges Related to Number Talks With Their Math Anxious Students and Non-Math Anxious Students, Which They Overcame by Conferencing with Students, Monitoring Participation and Maintaining Classroom Norms.

4.4.1 Math educators experience challenges with student participation, behavior and not having enough instructional hours in the day.

4.4.2 Math educators use a wide range of strategies including conferencing and modifying to respond to the challenges they experience during number talks.

4.5 Math Educators use a Variety of Resources When Designing and Implementing Number Talks Including Support Staff in the School, Online Resources and Board-Developed Resources.

4.6 Conclusion

Chapter 5: Conclusion

5.0 Introduction

5.1 Overview of Key Findings and their Significance

5.2 Implications

5.2.1 The educational community

5.2.2 My professional identity and practice
5.3 Recommendations 63
   5.3.1 Teachers 63
   5.3.2 School boards 64
5.4 Areas for Further Research 64
5.5 Concluding Comments 65

References 67

Appendix A: Letter of Consent 70
Appendix B: Interview Protocol/ Questions 72
Chapter 1: Introduction

1.0 Introduction to the Research Study

In recent discussions about education there has been a focus on the different methods educators should be using to teach math to their students and how these methods can affect student achievement. These debates about math are important because the way math is taught in the classroom directly affects the way math is learned in the classroom (Boaler, 2002). Discussions about math mainly focus on whether reformed math or traditional math is better for students learning and perceptions of math (Trafton & Hartman, 1997; Boaler, 2002; Parrish, 2011; Richardson, 2011; Melville, Kajander, Kerr, & Holm, 2013; Boaler, 2016). The way math has been taught in the past is referred to as traditional math and it involves teachers transferring their knowledge to their students through lessons, then afterwards students will practice and repeat what they were taught in the lesson. Students are expected to learn basic steps and then answer questions independently, quickly and accurately. The problem with teaching math in this more procedural way is that students may not understand the conceptual basis of what they are learning, meaning that they will have a difficult time with problem solving and application (Melville, Kajander, Kerr, & Holm, 2013; Boaler, 2016). Traditional math may cause students to fall behind, develop poor self esteem and can even result in them developing math anxiety.

Scholars define math anxiety as “a feeling of tension, apprehension, or fear that interferes with math performance” (Ashcraft, 2002 p. 181). The seriousness of math anxiety is shown through the impact it can have on the brain by impeding the working memory, which is crucial for the execution of multi-step math problems (Ashcraft & Krause, 2007; Boaler, 2014; Beilock, Sian, Lindsay, Kulp, Holt, & Carr, 2004). Math anxiety does not only impact student success and sense of self-esteem in the classroom but it also affects students’ career choices and their ability
to be accepted into higher education programs (Jameson, 2014). The information gained from research done on math anxiety is one of the reasons why reformed math should become a focus in mathematic classrooms.

Reformed math takes a more constructivist approach to teaching and learning where the teacher is a facilitator of learning and not the main source of knowledge in the classroom. Instruction in reformed math also tends to take a more conceptual approach rather than focusing on the regurgitation of facts (Trafton & Hartman, 1997; Boaler, 2002; Parrish, 2011; Richardson, 2011; Boaler 2016). These approaches align well with the Ontario Mathematics Curriculum. For example the Ontario Mathematics Grade 1-8 Curriculum (2005) is “based on the belief that students learn mathematics most effectively when they are given opportunities to investigate ideas and concepts through problem solving and are then guided carefully into an understanding of the mathematical principles involved” (p.4). A newly widespread practice that aligns with the philosophies of reformed math and the Ontario Curriculum is number talks. Number talks are short conversations where students are presented with a math problem and then encouraged to solve the problem using mental math strategies that work best for them before sharing their solutions with the class (Parrish, 2011). These number talks involve several processes designed to make students more comfortable and fluent in math, which can help increase their achievement (Parrish, 2011; Richardson, 2011; Boaler, 2016). Although there is little research done on the effect of number talks on math anxiety many of the solutions to math anxiety that have been proposed by researchers align well with this practice (Trafton et al., 1997; Louwerse, Straatemier, Van Der Ven, Klinkenberg, Van Der Maas, 2013; Boaler, 2014; Ramirez, Gunderson, Levine, Beilock, 2014). This study has been designed to examine teachers’
perspectives on how number talks can impact students with math anxiety or if they have any effect at all with the goal of informing future teaching approaches in mathematics.

1.1 Purpose of the Study

The purpose of this study is to learn teacher perspectives on the extent that number talks are beneficial to students who are at risk of developing math anxiety or have math anxiety. The main goal of my research is to inform future teaching practices. I aim to share these findings with the broader educational community in hopes of giving a clearer understanding of the practical strategies that can be used to support students with math anxiety.

1.2 Research Problem

Research has shown how math anxiety can negatively impact a student’s sense of self-esteem, motivation and achievement in the classroom (Ashcraft & Krause, 2007; Ashcraft & Moore, 2009; Jansen, Louwerse, Straatemeier, Van der Ven, Klinkenberg, Van der Maas, 2012). This is important because a student’s sense of self and motivation are key factors for success and enjoyment at school. If a student has negative experiences at school it can impede their learning and prevent them from continuing on to higher education.

While there has been plenty of research done on math anxiety at schools in the United States there has been no research done on how children are being impacted specifically in Ontario public schools. There has also been very little research done on math anxiety in elementary age students because the research is mainly dominated by studies done on adults or students completing their post graduate degrees. While studies on adults are important for learning the long-term impact of math anxiety, they do not clearly explain how math anxiety develops or how it can be prevented. This research project will fill the gap in the literature by
listening to the lived experiences of instructors who teach elementary aged students in Ontario classrooms.

According to the EQAO math scores have been steadily declining over the past five years. The results are especially concerning for Grade Six students where the 2013-14 test showed that only 54% of students are achieving level three or four on the test (EQAO, 2013-14). These results show that around half of the students in Ontario are not able to meet the grade expectations in mathematics. While there are many problems with standardized tests accurately measuring the achievement of students these results give a general overview of Ontario students’ math levels. Knowing how Ontario students are doing in math is important to this study because math anxiety and achievement are closely linked.

The EQAO results show that there needs to be further investigation into why students are achieving poorly on these tests and what strategies can be used to help them. Number talks are a strategy that has been proven to help with students’ confidence and achievement in math (Parrish, 2011). While number talks are currently being used in Ontario classrooms they are a relatively new practice meaning that there is little research on the long-term effects they can have on students. Although this study focuses on the relationship between number talks and math anxiety, it will also explore how teachers develop math talks and implement them in the classroom to gain better understanding of this practice.

1.3 Research Questions

This study will examine a small sample of Ontario elementary school teachers who use number talks regularly in their classrooms to answer the larger question: How do a sample of Ontario elementary school teachers use number talks in their classroom and what outcomes do they observe from their students who are showing signs of math anxiety? From this focus I hope
to discover the challenges, resources of support and successes Ontario teachers have with
to discover the challenges, resources of support and successes Ontario teachers have with
number talks.

Subsidiary questions that will consequently be addressed in the study include:

1) What indicators of math anxiety do these teachers observe from students? How do they
know students experience math anxiety?

2) What range of instructional strategies and approaches do they believe are most effective
for responding to math anxiety?

3) Why do teachers use number talks in their classrooms? From their perspective, what are
the benefits of using number talks as a strategy for teaching math?

4) What factors do teachers take into consideration when designing number talks? What
resources do they use when designing number talks and are these resources readily
available?

5) What challenges do teachers encounter during number talks, specifically with their math
anxious students and how do they respond to these challenges?

1.4 Background of Researcher

The first time I heard about math anxiety was early into my Masters of Teaching program
at the University of Toronto. I became interested in the subject because it helped me make sense
of my own educational experiences with mathematics. In my early to recent school years I had
always strongly disliked math and believed that this dislike stemmed from simply being bad at
math. I felt that I was inherently bad at math and would never be good at math no matter how
hard I tried. However, doing further research on math anxiety and the new ways math is being
taught in classrooms today showed me that my dislike of math and poor achievement may have
been caused by math anxiety and does not relate to my intelligence.
When I decided to pursue teaching I remember feeling nervous about the prospect of having to teach math to students. I thought that if I’m terrible at math than I will probably be bad at teaching math and this feeling shows how math anxiety, in varying degrees can still occur in adults. It was this feeling of apprehension combined with my personal interest in math anxiety that encouraged me to pursue this topic further. As a future teacher I’m interested in learning more about how math anxiety can be prevented. Learning more about the way math is being taught in schools today and the tension between reformed and traditional math approaches made me interested in seeing how different ways of teaching math can impact students math anxiety. From what I remember of my public school education I was taught in the traditional style of math where I was delivered lessons about concepts I did not fully understand and then expected to apply these concepts using worksheets and homework books. The learning style was mainly independent and involved paper and pencil activities. While this style of learning may benefit some students, I felt that it did not match by own learning style and I easily fell behind. Activities such as number talks, centers, proofs and math games might have helped make me more engaged in math class, which would have improved my achievement and attitudes towards math.

I had the opportunity to do number talks while on my first practicum and I was amazed at how well the students could solve problems using mental math. It was also interesting to see the many different strategies they used to solve one problem. It made me wonder why in the past so much emphasis was placed on standard algorithms and paper, pencil solving when in real world situations it is more valuable to have mental math problem solving skills. Another thing I observed was how even the children who rarely participated in class often volunteered to share their answers during number talks. This could be due to the wait time, the lack of focus on
getting the perfect answer and the openness to multiple ways of solving a problem. These things seemed to eliminate anxiety in the classroom, which is why I decided to look at the relationship between number talks and math anxiety.

As a future mathematics teacher, I’m interested in learning about different ways to engage and motivate my students. I see a real opportunity to improve student achievement through new math strategies such as number talks. I want to learn how to prevent my students from having math anxiety because I have personally experienced the way that it can negatively impact an individual’s achievement and self-concept. By focusing on number talks and the effect they have on students with math anxiety, I hope to gain a better understanding of how to help students who are struggling in math.

1.5 Overview

This qualitative study is conducted through a review of the literature and semi-structured interviews with three teachers. The research project is organized into five chapters. In the second chapter I review the literature on math anxiety and number talks. Then, in Chapter Three, I describe the research methodology including information about the participants, semi-structured interviews and limitations. In Chapter Four I report and discuss my research findings. Lastly Chapter Five is a review of the implications of my research findings and includes recommendations for future research. My references and a list of appendices will be found at the end.
Chapter 2: Literature Review

2.0 Introduction

In this chapter I will review the literature on current instructional approaches in mathematics and how these approaches can benefit students who have math anxiety or are at risk of developing math anxiety. This review will focus specifically on the relationship between math anxiety and a new instructional approach called number talks. First I will outline the indicators of math anxiety, the causes of math anxiety and the impact of math anxiety to provide a comprehensive overview of this problem that is impacting many students. Next I will describe possible solutions to math anxiety and show how many of these solutions align with the instructional philosophy of number talks. Finally, I will go more in-depth to describe number talks, the perceived benefits they have for students and how these benefits could possibly prevent math anxiety and assist students with math anxiety.

2.1 Indicators of Math Anxiety

Math anxiety has been well researched by academic scholars that have studied the negative impact of this disorder in both children and adults (Ashcraft, 2002; Ashcraft & Krause, 2007; Jameson, 2014). Their results show that math anxiety is something that needs serious attention in today’s classrooms. Many scholars have described math anxiety as a negative feeling of tension, apprehension or distress that children and adults experience when faced with mathematical problems (Ashcraft et al., 2007; Ashcraft et al., 2009; Jansen et al., 2012). These negative feelings that individuals have when they are posed with a math problem are similar to what individuals with general anxiety would have except they are triggered by a specific situation (Faust 1992; Ashcraft, 1995; Young, Wu, & Menon, 2012). This research is helpful in understanding the complexities of math anxiety.
In a study of students aged seven to nine that focused on the neurological impact of math anxiety, it was found that math anxiety has many parallels with other phobias and anxiety disorders (Young et al., 2012). Using magnetic resonance imaging (MRI) it was confirmed that areas of the brain that are often over stimulated for individuals who have generalized anxiety disorders were also stimulated when math anxious children performed math problems (Young et al., 2012). The scans show that math anxious students had hyperactivity in the amygdala, which regulates the processing of negative emotions (Young et al., 2012). They also had a shortage of activity in the posterior parietal and prefrontal cortex areas that are important for processing mathematical problems and working memory (Young et al., 2012). Other research done on the physical evidence of math anxiety found that students who identified as math anxious had increased heart rates while performing difficult math problems but when the same participants were asked to perform difficult verbal tasks their was no change in their heart rate (Faust, 1992; Ashcraft, 1995). These discoveries about the neurological and bodily evidence of math anxiety can have a profound impact on the identification and treatment of math anxiety. They are helpful in showing that math anxiety is not merely a passing feeling, but a scientific disorder that can impact the physical body.

Research on the neurological impact of math anxiety shows the reasoning behind some of the symptoms that educators and researchers have witnessed in their practice. The indicators that have commonly been discussed include: withdrawal, avoidance, low performance, frustration, and negative attitudes towards math. Avoidance and withdrawal were the two indicators most commonly found by researchers and they were shown to have a negative impact on students’ performance in mathematics (Ashcraft et al., 2009; Turner, Midgley, Meyer, Gheen, Anderman, & Patrick, 2002). Avoidance and withdrawal can be observed in the classroom by assessing
students’ engagement in lessons, studying habits, homework completion and voluntary participation (Ashcraft et al., 2009). Students who show symptoms of withdrawal may also avoid seeking help, purposely do poorly on their assignments and give up easily (Turner et al., 2002). In terms of performance a child who struggles with math anxiety may have difficulties with number sense, which is a concern because research shows that a student’s comfort with number sense in primary grades is a strong predictor of their future math abilities (Ashcraft et al., 2009). These indicators of math anxiety give teachers and researchers the ability to measure and assess math anxiety in classrooms, which is beneficial because it can help educators create plans to help these students. The indicators of math anxiety also provide a platform from which educators can develop new ways of teaching math.

2.2 The Causes of Math Anxiety

There are many different factors that can result in the development of math anxiety in elementary aged students. The causes of math anxiety provide a deeper understanding of some of the indicators discussed in the previous section that are being observed in classrooms by researchers and educators. In a study of 150 first and second grade students it was found that children’s experience of math anxiety did not directly relate to grade level, reading level or parental income (Ramirez, Beilock, Sian, & Park, 2014). Instead it was found that math anxiety could develop because of unsupportive teaching styles, lower math abilities or working memory capacity and vulnerability to anxiety.

2.2.1 The impact of teaching style on math anxiety

There are many different strategies educators can apply to their teaching and these approaches can have a profound impact on a student’s achievement and motivation at school. It is believed that math anxiety is developed in the classroom and that unsupportive learning
environments are shown to produce the highest number of math anxious individuals (Turner et al., 2002; Ashcraft et al., 2007). When a student repeatedly receives negative feedback in math they will begin to internalize these criticisms and try to avoid math activities or courses in the future (Jameson, 2014). Constant negative feedback can also affect a student’s motivation to persevere through more challenging mathematic problems. If they are used to always doing poorly they are at a greater risk of giving up because they have developed the mentality that they will always be bad at math regardless of how hard they try (Jameson, 2014). This research shows the importance of providing detailed positive feedback to students that will encourage them to persist through challenges and grow.

Symptoms of math anxiety were also more commonly found in classrooms that had a more performance based atmosphere rather than a mastery atmosphere (Turner et al., 2002). While performance based classrooms emphasize the importance of the final product, mastery classrooms focus more on the learning experience. Activities such as timed tests that have been found to have a negative impact on students learning and self-efficacy would be found in a classroom that uses performance bases goals (Boaler, 2014). Timed tests fall into the performance-based category because they focus more on the end results rather than the process of learning. Since these tests are generally fast paced they can also cause students to feel unnecessary stress that prevents them from experiencing deeper thinking (Ashcraft, 2007; Boaler, 2014). In performance-based classrooms, a message that is often communicated to students is that the goal of education is to be better than their peers. As a result, academic achievement becomes a competition rather than a personal growing experience (Turner et al., 2002). In these situations where performance is placed as a priority in the classroom students who struggle will try to protect themselves by developing “self-handicapping” strategies that will
make others believe they are controlling their own ability (Turner et al., 2002; p.88). For example when a student is called to the board to complete a math problem in front of his peers and does poorly they may become embarrassed and dread having to go through the same experience again (Ashcraft et al., 2007). In these types of situations many students find it easier to deflect attention from their abilities by making it seem like they are doing poorly on purpose (Turner et al., 2002). But by deflecting attention from their abilities students are not meaningfully engaging in learning opportunities because the majority of their brain energy is being consumed by protecting their self worth.

### 2.2.2 Math ability

Research shows that students’ overall aptitude is only weakly related to math anxiety, meaning that it is not necessarily students with lower intelligence who are developing math anxiety (Ashcraft, 2002). This finding may explain the reasoning behind why many students who have math anxiety excel in other subjects such as literacy and science, but continue to be below average in math (Ashcraft, 2002). Despite these findings there has been recent research done on primary students that suggests that low math ability can predict the development of math anxiety (Jansen et al., 2012). Both of these findings show that a relationship exists between math anxiety and math ability regardless of whether math anxiety is the cause or effect.

This debate between whether low intelligence can predict math anxiety can be explained by working memory. Working memory is essential to problem solving because it is where new information is stored and old information is retrieved (Ashcraft, 2002; Ashcraft et al., 2007; Beilock et al., 2004; Boaler, 2014; Ramirez et al., 2013). Students that have a lower working memory may struggle more in math causing them to develop math anxiety (Ashcraft et al., 2009). Working memory’s effect on math anxiety becomes more pronounced when students are
working on multistep math problems. This occurs because math problems with multiple steps place more weight on the working memory making it difficult for students who already have a deficiency in their working memory to complete the problem (Ashcraft, 2002). If math anxiety becomes more pronounced when students begin working on multistep problems than this may be why a large majority of the research focuses on adults and post secondary students. While most of the research focuses on math anxiety and working memory in adults a study of first and second grade children shows that deficiencies in working memory are also an issue in the early grades (Beilock et al., 2013). These studies show how working memory, math ability and math anxiety are closely tied because of the way a low working memory can impact students’ performance and self worth in math class. However not only does working memory make students more susceptible to math anxiety, it can also be damaged when students have math anxiety. The impact math anxiety has on working memory will be discussed in more detail in the section on the impact of math anxiety.

2.2.3 Math anxiety and generalized anxiety disorders

Research on the physiological impact of math anxiety has shown how math anxiety and generalized anxiety disorders are closely linked (Young et al., 2012). Studies have also shown how students who are prone to anxiety are also more likely to develop math anxiety. Generalized anxiety has a negative affect on academic achievement and a strong sense of self-esteem will prevent anxiety from occurring in the classroom and negatively impacting a child’s experience (Galla & Wood, 2011). In a study of children aged five to twelve it was found that students who were better at handling negative emotions because of their emotional self-efficacy were less likely to experience symptoms of math anxiety in the classroom (Galla et al., 2011). This study shows that not all children are affected by math anxiety in the same way because they cope with
negative experiences in different ways. It was also reported in a different study that when reflecting back on their experiences in the classroom college students said that their math anxiety was caused by the embarrassment they felt in front of their teachers and peers from having to solve math problems on the blackboard (Ashcraft et al., 2009). These students show how being susceptible to public embarrassment can cause feelings of general anxiety, which then becomes connected to math when teachers have their students publicly practice math (Ashcraft et al., 2009). While anxiety and self-concept are very personal, these studies show how in many cases math anxiety can be prevented in the classroom by avoiding certain practices that can cause anxiety in the students.

2.3 Impact of Math Anxiety

Math anxiety can have several negative effects on students making it an important issue to be aware of as an educator. For example Ashcraft and Moore (2009) claim, “math anxiety is a significant impediment to math achievement, one that affects a considerable portion of the population and one that merits serious attention both in terms of assessment and intervention” (pg. 197). This statement would be agreed upon my many other researchers in the field who have found that math anxiety can have a serious impact on working memory and motivation, which both effect achievement in mathematics.

2.3.1 Working memory

Working memory is an essential tool for the completion of math problems because it is where new information and already stored information come together for a specific purpose (Alloway & Gathercole, 2007). For example when adding, the brain must process the numbers to be added (new information) while also recalling how to solve the addition problem (stored information). As math problems become more complex (e.g. problems that involve multistep
computations, the mental retrieval of formulas and sequencing of mental procedures) a strong working memory becomes even more important (Galla et al., 2011; Jansen et al., 2012). The problem is that math anxiety impacts the working memory by preventing it from functioning to its fullest potential (Beilock et al., 2004; Ashcraft et al., 2007; Ramirez et al., 2013; Boaler, 2014). This happens because the worry that math anxious individuals feel when faced with a mathematical problem consumes a large part of the working memory making it difficult to complete the task (Beilock et al., 2004; Jansen et al., 2012). Working memory and the effect it has on the processing of information could explain why researchers have found that math anxiety is independent from what students are actually capable of achieving in math and other subjects (Ashcraft et al., 2009).

2.3.2 Motivation

Ashcraft and Krause (2007) ask: “Is lower performance on a math task due to math anxiety or to lower mastery and achievement in math?” (p. 245). Studies on working memory and math anxiety would show that lower performance is caused by math anxiety because of the negative affect it has on the working memory. Whereas research that focuses on motivation and math anxiety would show that lower performance is caused by falling behind in school and a lack of mastery in math. This is because the higher an individuals math anxiety is the lower their learning and motivation will be in math class (Ashcraft et al., 2007). When a child receives frequent negative feedback and also feels frustrated in class they can develop negative attitudes towards mathematics that can continue to trouble them their whole life (Jansen et al., 2012). Any negative feelings a child develops towards math can cause “math avoidance”, meaning that the child will avoid doing math coursework leading to them achieving to poorer grades and learning less than their non-math anxious peers (Jameson, 2014). Math avoidance also continues through
higher education and adulthood because math anxious individuals will avoid taking elective math courses and avoid careers that involve math (Ashcraft et al., 2007; Ashcraft et al., 2009; Jansen et al., 2012; Jameson, 2014). Generally math anxiety leads to math avoidance, making students who have math anxiety learn less than students who have no math anxiety because they will avoid math through their whole educational career.

2.4 Reinforcing Conceptual Understanding with Number Talks

Conceptual understanding in mathematics involves being able to comprehend larger math ideas and apply them to a variety of different situations. Despite the importance of conceptual learning, math is often taught in a more procedural way meaning that there is more of a focus on specific steps, rules and procedures. Parrish (2011) shows how procedural teaching negatively impacts student-learning claiming that “our classrooms are filled with students […] who view mathematics as a collection of rules and procedures to memorize instead of a system of relationships to investigate and understand” (p. 189). Math is often seen as being a fixed subject because of the narrow and closed tasks that are often involved in math lessons (Boaler, 2014). This mindset can be harmful to students because as discussed in previous sections, students who are susceptible to math anxiety or already have math anxiety will struggle even more in a classroom that uses procedural teaching approaches. They will suffer because their working memory will be consumed by stress and worry for getting the correct answer or solving the problem in the right way as told by the teacher (Turner et al., 2002; Beilock et al., 2004). By including instructional approaches such as number talks in daily classroom routines that focus on meaningful learning, understanding and intellectual growth students will be more open to exploring number relationships and making mistakes that they can then learn from.
Teachers can also make their students’ learning more meaningful by differentiating their instruction to meet the needs of each of their students. Research shows that when students practice math at their own level their ability will naturally gradually improve (Jansen et al., 2012). This is because students will feel encouraged to practice when they are successful (Jansen et al., 2012). Instead, when a student consistently receives negative feedback they will most likely begin to internalize self-doubts about their math ability and avoid math experiences, which will negatively effect their achievement (Ashcraft et al., 2007; Ashcraft et al., 2009; Jameson, 2014). Focusing on conceptual approaches to teaching can help instructors differentiate their instruction. For example students who have math anxiety will often have difficulties following specific steps that have little meaning to them because of the way math anxiety affects working memory (Beilock et al., 2004; Ashcraft et al., 2007; Ramirez et al., 2013; Boaler, 2014). Number talks can help students who struggle with following procedural steps by showing that there is multiple ways to problem solve. Number talks also validate the use of whatever strategy that works best for the individual student.

Math anxious students may also need more time to think and process information compared to non-math anxious students. Since stress and pressure can impact the working memory, these students need an environment that is free of unnecessary stress in order to perform multiple mathematic operations (Galla et al., 2011; Jansen et al., 2012). Using “quiet thumbs” during a number talk can help math anxious students by giving them more time to think without feeling pressure from the visibly raised hands of their peers (Boaler, 2014). The lower visibility of raising a thumb may also encourage students who take longer to process to continue to think instead of relying on their peers who process faster for all of the answers. Overall number talks are a practical strategy teachers can use to accomplish many goals such as
implementing differentiated learning in the classroom and showing the intrinsic value of learning to their students.

2.4.1 Number talks

Number talks are short discussions about mathematical problems solving that can help students develop a strong understanding of number sense and math fluency (Parrish, 2011; Richardson, 2011; Boaler, 2014). Number sense is an individual’s ability to understand what numbers represent and their relationship to one and other. This type of math often involves addition, subtraction, multiplication, division and place value. Math fluency is an important part of number sense because it is a person’s ability to easily work with numbers and perform operations. Most number talks begin with the instructor writing a question or problem on the board and then giving students time to solve it using mental math (Parrish, 2011). These questions can align with the unit the instructor is currently teaching in mathematics. However teachers should be careful not to focus on achieving a certain answer from their students or conveying a specific message during the number talk since it is an activity that is meant to be open to several possible solutions and learnings (Parrish, 2011). What this means is that teachers must their shift roles from being the main source of knowledge in the classroom to being a facilitator for their students during these discussions (Parrish, 2011). This may be an adjustment for teachers who commonly assume the role of sole authority in the classroom especially since that may have been what they have experienced in their own educational background. It also may be difficult at first for students who are used to looking to their teachers for information and answers rather than generating it on their own.

During a number talk when a student has thought of a possible solution instead of raising their hand they are asked to signal that they are ready with their fingers (Parrish, 2011). They can
raise a different finger for every solution that they can come up with for the particular problem (Parrish, 2011). This process is beneficial to all learners because it encourages early finishers to continue to think and challenge themselves while students that need more time to process can take the time and not be excluded from the conversation. Once the majority of students have thought of a solution to the problem the teacher will ask certain students to share their answers with the class focusing on the steps they used to get to their answer (Parrish, 2011). It is important for students to explain their reasoning because it helps the students who are sharing develop logical reasoning skills while also exposing other students to multiple strategies for solving each problem (Parrish, 2011; Boaler, 2014). At the end of a number talk students should have had the opportunity to hear and share a variety of different solutions. By including number talks a few times per week students will begin to develop a better understanding of logical mathematical reasoning and number sense (Boaler, 2014). These number talks will not only foster students’ growth in mathematical knowledge but they also can create a safe environment where students can deeply engage in math concepts without any external pressures such as achieving the correct answer or being publicly embarrassed in front of their peers.

2.4.2 Number talks as a solution to math anxiety

In the existent literature there are many suggestions and potential “next steps” for teachers to assist students with math anxiety. Interestingly, many of these solutions align with the relatively new classroom practice called number talks. Two of the main solutions that have been proposed in the research are the development of self-regulation and adapting a more conceptual approach to teaching mathematics. While self-regulation is something that can be taught in the classroom the research done on specific conceptual instructional approaches focuses on certain techniques teachers can use to prevent math anxiety or help students with math anxiety. Some of
these approaches include adapting instruction to students needs, emphasizing learning as a growing process and motivational support (Turner et al., 2002; Jansen et al., 2012). In turn, many of these conceptual instructional approaches can foster the development of self-regulation in students by giving them more responsibility for their own learning. When students take responsibility for their own learning they are generally more motivated at school and therefore are more successful (Hartman & Trafton 1997; Galla et al., 2012; Jameson, 2014). Self-regulation and conceptual understanding are key strategies for student success that are built during number talks. Since number talks are a relatively new practice there is little research about the long-term affect of them on students’ achievement and comprehension of math. However, drawing on other practices that have been helpful to students and comparing them to number talks shows how this specific practice could benefit students with math anxiety.

2.4.3 Self-regulation, motivation and number talks

Educators need to teach their students that academic achievement is not measured in the ability to memorize facts and procedures but the ability to learn from mistakes, problem solve and apply knowledge. A study of over 40 primary school teachers shows how valuable self-regulation is in education because of the way it makes students more confident, independent and capable in the classroom (Hartman et al., 1997). Similar to number talks in these classrooms students were given a math program or task to accomplish and were then encouraged to solve the problem in their own way using whatever materials they liked (Hartman et al., 1997). After they finished solving the problem the students share their solution with their classmates (Hartman et al., 1997). By including sharing as part of the daily classroom routine in math, students were regularly participating in conversations about logical reasoning with each other making the teacher not the main source of knowledge in the classroom. When the students became more
reliant on their own knowledge and the knowledge of their peers they felt more motivated to engage in their work because they were in control of their learning and were not being forced to follow rules they may not have even understood (Hartman et al., 1997). Like this exercise number talks instil a similar feeling of responsibility of learning in students by making them figure problems out in a way that makes sense to them. This is valuable because instead of students relying on their teachers for giving them the solutions they are being engaged in deeper thinking and understanding. The research on the benefits of fostering self-regulation in the classroom can be further supported by Bandura’s theory on human agency. His theory explains that human agency is driven by people’s beliefs about their ability to control events in their lives (cited in Jameson, 2014). This theory proves that providing students with opportunities to control their learning and share their ideas makes them more motivated to learn. While this can seem like a daunting task to educators, the practical solution of adding short number talks to their daily routine can have a positive impact on self-regulation, motivation and intellectual development.

2.5 Conclusion

With the slow decline of EQAO scores and the prevalence of math anxiety, there is more motivation for researchers to investigate why these problems are occurring and the impact they might have on students’ futures. Despite the plenitude of research on the topic of math anxiety and the debate on the best approaches for teaching math, there is a lack of research on specific, practical approaches teachers use to help struggling students. This may be why teachers tend to continue to teach math in a more traditional way rather than exploring how different approaches to teaching can impact their students. The literature would benefit from more teacher-guided research that discusses what is happening on a daily basis in classrooms. Much of the current research is guided by academics that work with participants in isolated situations. While this may
be beneficial to learning more about math anxiety because isolated situations gives researchers the ability to control the environment, it gives future educators little information about what math anxiety would look like in a traditional classroom. Since math anxiety is an issue that effects teachers and their students it would be valuable to have more practical strategies and research to support these strategies. Although number talks are a practical strategy teachers can use there is no long-term research that shows how they impact student achievement. We can only infer from other strategies that have been successful that number talks will work to support students with math anxiety. My research fills these gaps in the literature by examining the practical strategies teachers use in their classrooms to support students with math anxiety. More specifically my research looks at how teachers use number talks to support their students’ conceptual understanding of math and whether or not this approach benefits students with math anxiety. My findings will show how teachers support students with math anxiety and how they successfully implement number talks into their math programs.
Chapter 3: Research Methodology

3.0 Introduction

In this chapter I describe the research methodology that will be used in this study. I begin by reviewing the general approach, procedures, and data collection instruments before elaborating more specifically on participant sampling and recruitment. I explain data analysis procedures and go over any ethical considerations that relate to my study. Relatedly, I identify a range of methodological limitations, but also speak to the strengths of the methodology. Finally, I conclude the chapter with a brief summary of key methodological decisions and my rational for these decisions given the research purpose and questions.

3.1 Research Approach & Procedures

This research study was conducted using a qualitative research approach involving a literature review and semi-structured interviews with experienced teachers. Qualitative research usually begins with a problem or observation, evoking inquiry, which leads to the collection of data in a natural setting through observation and interviews (Creswell, 2010). Using qualitative research that is grounded in the source of inquiry’s natural setting is valuable to both the researcher and participants. This is because typically the final product, especially since the data collection is interviews, includes both the voice of the participants and the reflexive positioning of the researcher leading to a deeper understanding of the issue of math anxiety and student success in math (Creswell, 2010). By including the voices of participants the research study presents an in-depth overview of the problem from multiple perspectives making it richer in information. Overall, qualitative research is typically holistic in nature meaning that it provides a “complex picture” of the problem by including multiple perspectives, identifying several
different factors that relate to the problem and presenting a larger picture of the issue it is
discussing (Creswell, 2010).

The use of qualitative research methods through semi-structured interviews is a suitable
method for this research study because the goal of the study is to learn about the relationship
between math anxiety and number talks from experienced teachers who have witnessed/
participated in these phenomena. Including the voices of experienced teachers in my research
provides value to my study because they see first hand the challenges and successes that occur in
the classroom when different strategies are enacted. Quantitative research would not sufficiently
answer my research question because numbers and large measurements will not be helpful in
providing a deep and complex understanding of my research problem (Kincheloe, 2003).
Therefore qualitative research using semi-structured interviews is essential to the success of my
study.

3.2 Instruments of Data Collection

The main tool used for data collection in this research study is a semi-structured
interview protocol. This type of interview provides the opportunity to hear about the participants’
diverse experiences and observations (Creswell, 2010). Semi-structured interviews are also
important to this type of study because numbers and statistics cannot answer my research
question that focuses on the lived, complex experiences of teachers. The semi-structured
interview format reveals certain qualities and intricacies that cannot be expressed in mere
numbers (Kincheloe, 2003). The semi-structured interviews I used in this study consisted of a
series of questions designed by myself that relate to my research focus but also leave room for
participants to elaborate and re-direct attention to areas previously unforeseen by myself. By
allowing the participants some freedom in their responses, important information about my research topic that was not previously considered was revealed.

3.3 Participants

In this section I review the sampling criteria that I established for participant recruitment, and I review a wide range of possible avenues for teacher recruitment. I have also included a section where I introduce each of the participants.

3.3.1 Sampling criteria

For the purpose of the study I interviewed a variety of experienced teachers who are dedicated to mathematics instruction. These participants met the following criteria in order to inform the study and respond to my research questions:

- Criteria #1 Educators need to have at least five years of experience teaching elementary aged students.
  - Rationale: These teachers will have plenty of experience teaching mathematics. They will also likely be able to speak to the evolution of mathematics instruction from when they first started teaching until now. Their extensive amount of experience will help inform future teaching practices.

- Criteria #2 At least one of the educators should have their math specialist and/or be a leader in mathematics education.
  - Rationale: Teachers who have extra training in mathematics will be more aware of current mathematical trends and problems. They will already be aware of math anxiety and the instructional practice number talks. Their background knowledge will provide valuable information to the study. However, it is also important to look at teacher’s perspectives that are not experts in math to gain a richer
understanding of the challenges teachers experience because not every teacher is a math specialist.

- Criteria #3 Educators should be using number talks regularly as part of the classroom practice or have used them regularly in the recent past.
  - Rationale: Teachers who frequently use number talks will be crucial to this study because they will have lots of knowledge about this practice. They will also be able to speak to the way number talks impact students.

3.3.2 Recruitment

Given the small-scale nature of the study and the methodological parameters I used convenience and purposeful sampling to recruit participants. Purposeful sampling involves selecting individuals that can inform the research study (Creswell, 2010). Being in the Master of Teaching program has given me the opportunity to be immersed in community of teacher colleagues and mentor teachers. Therefore I chose to recruit participants from existing contacts and networks. More specifically, I provided my sampling criteria to my host teachers who then referred me to other teachers who better suited the criteria.

Using convenience and purposeful sampling offers a simpler way to recruit participants than other methods but it also has some drawbacks. Choosing participants from my own network takes away some of the credibility from my research because it may not provide a wide range of experiences and information to the study (Creswell, 2010). However, given the parameters of the study convenience and purposeful sampling is necessary because it is crucial that I interview participants who have experience with math anxious students and with teaching number talks. Most qualitative research requires researchers to purposefully seek out candidates who have experienced the phenomenon that is being researched (Creswell, 2010). While seeking out
participants who share certain qualities may make the study seem disreputable it is more
important to be learning from teachers who can give depth to the study because they share
similar experiences.

3.3.3 Participant biographies

My first interviewee Angela has been teaching elementary, junior and intermediate students for the past twenty-two years in Ontario. She predominantly taught junior and intermediate students in mathematics on rotary until the past few years. In the past Angela has worked as a high school mathematics coach where she worked with mathematics teachers to improve student achievement and engagement in mathematics. She currently works in as the intermediate cert, numerous coach and does coverage periods where she teaches math. Angela has always had a strong interest in mathematics and was influenced by her math teachers to pursue a career in mathematics.

My second interviewee Megan has been teaching elementary aged students for the past nine years in Ontario. In the past she has taught Grade Two, Three and Six in both the English program and French Immersion program. Currently she teaches Grade Three students for the English side of French Immersion, meaning she is responsible for teaching Literacy and Mathematics. She has also recently become involved in a new math strategy her school is implementing as the Grade Three team representative. Megan meets with other teachers representing their grade teams at the primary grade level where they brainstorm ideas to improve their mathematics program. She is then responsible for communicating these ideas to the other Grade Three teachers. Megan places a special focus on her math program because she sees that it’s an area where many students struggle. She strongly believes that every student can learn math.
My third interviewee participant Cathy has been working as a teacher for the past fourteen years in Ontario. She began her teaching career teaching high school English and Economics at a private school. Since then she has taught a variety of grade levels from three to eight in public elementary schools. Currently she works as a full time Grade Four teacher on the English side of a French Immersion school. She teaches all core curriculum subjects. Cathy helps students run a variety of clubs such as the cooking club and has also coached intermural sports. She also helped develop Math Night, a night where students come to the school and rotate through a variety of math centers that cover different concepts such as multiplication and transformational geometry.

3.4 Data Analysis

There are three main approaches to qualitative data analysis: interpretivism, collaborative research and social anthropology (Miles, 1994). For the purposes of this study I used interpretivism and collaborative research. I used collaborative research methods by collecting data from teachers currently working in the field of education and then using their knowledge and experience to inform future teaching practices. But I also used interpretivism to analyze the data I receive from these teachers through the semi-structured interviews.

Using interpretive methods, I coded the interviews, looking for common themes and divergences in the data that are relevant to my research question. A code is a word or short phrase that summarizes or symbolically represents a collection of qualitative data (Saldana, 2015). The type of coding that best suited my research was descriptive and value coding. I chose to use these two lenses when coding my research because I feel that they captured both teacher practices and beliefs, which are important for answering my research question. After coding, I used the codes that I made to draw similar themes from my research that will be outlined in
Chapter Four. I also not only looked at the literal data that I collected but I also be looked at null data to see what participates did not speak to in their interviews and why this matters.

3.5 Ethical Review Procedures

There are several ethical procedures that have been considered in this research project to ensure the privacy and protection of participants. One of the purposes of qualitative research is to empower participants to share their stories and experiences (Creswell, 2010) and in order to encourage them to share their stories the researcher must create a safe space for the participant. For this reason, all participants were asked to sign a consent letter (Appendix A) that gives their permission to be interviewed and video recorded. The consent letter gives an overview of the study, address ethical implications and specifies expectations of participation. I also included in the consent letter that there are no known risks to participating in this study. This letter ensures that the participant is fully aware of what they are participating in before the interviews are conducted. They are also assigned a pseudonym and will be notified of their right to withdraw from participation in the study at any time. Any indicators of the participants’ identity such as relation to their schools and students will also remain confidential. After the interviews are conducted participants were given the opportunity to review transcripts and clarify or retract any statements they made during the interview. These ethical considerations protect the participants and ensure that they are comfortable participating in the research project.

3.6 Methodological Limitations

Given the ethical parameters this project has approval for I was restricted to interviewing teachers, which limits the scope of the research. The research study is limited even further because due to the timing of the project I was only able to interview three teachers. This means that I was unable to include the experiences of students or parents in my research or be able to
generalize the experience of teachers. These limitations impact the study because as good qualitative research generally includes a variety of perspectives (Creswell, 2010. However, even though I was not able to collect a large, diverse sample of data, I was able to go more in-depth with the data I collected. For this reason, the study has many strengths despite its weaknesses. For instance the interviews allowed teachers to speak to issues that matter to them the most and validated teachers’ voices and experiences. The interviews were also a good opportunity for teachers to reflect on their experiences and make meaning from these experiences. By dedicating plenty of time to each of these teachers I was able to allow for a more in-depth analysis of the research problem.

3.7 Conclusion

This chapter provided and overview of the research methodologies that are used in this study. The data collection consists of semi-structured interviews with teachers who are experienced in mathematics education and a literature review that summarizes current research on math anxiety and number talks. I used convenience and purposeful sampling by choosing teachers to interview from my own network that fit my sampling criteria, meaning that they will all be knowledgeable of number talks and math anxiety. I interviewed three teachers, one is a math specialist and the other two place a special focus on math in their classrooms. All participants use number talks regularly as part of their math program making them able to speak to how they support students with math anxiety. This chapter also outlined the ethical implications of the research study and how I ensured that participants felt comfortable during the data collection. In the next chapter I will report the research findings.

Chapter 4: Research Findings
4.0 Introduction

In this chapter I will review the findings from my interviews with three experienced math teachers. This chapter will explore the following themes related to my research question: How do a sample of Ontario elementary school teachers use number talks in their classroom and what outcomes do they observe from their students who are showing signs of math anxiety? Firstly, I will discuss how math educators recognize the importance of closely observing students because math anxiety can come in a variety of forms. Secondly, I will explain how math educators believe that number talks are a strategy that benefits all students’ math ability including students who have math anxiety. However, math educators also have experienced similar challenges with planning and implementing number talks mainly with time constraints and behaviour. These teachers have overcome these challenges with a variety of strategies including conferencing with students, monitoring participation and reinforcing classroom norms. Lastly I will elaborate on the online resources, in school support staff and board developed resources teachers use to support their teaching of number talks and their students with math anxiety.

4.1 Math Educators Recognize the Importance of Closely Observing their Students because Indicators of Math Anxiety Come in a Variety of Forms.

All participants spoke to the value of knowing their students and closely observing their behaviours in the classroom to see if they have math anxiety. They have observed many different signs of math anxiety from their students that range from behavioural to emotional. Students can at times also show several different signs depending on the situation. While most participants agreed that math anxiety was fairly easy to detect, one participant found that math anxiety was difficult to detect and could sometimes be confused for other issues that were impacting students’ math ability such as personal issues and learning disabilities. However, all participants
agree that close observation assisted them in discovering their students’ math anxiety and helping them in the classroom.

4.1.1 Math educators recognize that certain behavioural, verbal and emotional indicators of math anxiety can be very obvious.

Angela has worked with students who have varying degrees of math anxiety. She explains that students who have math anxiety often have a difficult time persevering in math class making it difficult for them to learn. She has witnessed students who “shut right down” as soon as math class begins and claims that this is due to feelings of anxiety. She recognizes that anxiety can come in a variety of forms with some indicators being more obvious than others. One of the most obvious indicators she mentions is a lack of participation from math anxious students. During number talks and large group activities students with math anxiety will rarely participate because they are fearful of being wrong in front of the teacher and their peers. She has observed a lack of participation from students with math anxiety also when it comes to completing and handing in homework and in class assessments.

Megan has noticed similar obvious signs of math anxiety from her students as Angela including lack of participation and avoidance behaviours. She explains her views on the indicators of math anxiety saying “I don’t think there is just one thing you are going to see” demonstrating that math anxiety comes in a variety of forms and can be different from student to student. She has observed students avoiding eye contact, biting nails and pretending to be busy doing something else to avoid working on math. She has also observed students show more physical signs of anxiety by saying they have stomach aches during math class or are constantly needing to go out the room for drinks of water.
Similar to the first two participants, Cathy has also observed obvious signs of math anxiety from her students where they shut down and use avoidance strategies. Some of her students have verbalized their math anxiety by saying “I’m no good, I’m never going to get it” showing a lack of confidence and perseverance in math. This attitude they develop towards math prevents them from working through math problems especially when they become more difficult. Cathy has also observed a student having panic attacks over solving math problems because the student could not remember the proper steps. She has even had students who show math anxiety by asking lots of questions and constantly being at her desk for extra help, which is very different from the students who exhibit their anxiety by not asking for help. The varying indicators that teachers have observed shows that math anxiety can be shown in very different forms depending on the student and the situation they are in.

Researchers have referred to some of the behaviours observed by these teachers such as pretending to be busy as avoidance or withdrawal and believe that they are some of the most common signs of math anxiety (Ashcraft & Moore, 2009; Turner et al., 2002). Studies have shown that when a student is feeling anxious when faced with a math task their brain will become over stimulated resulting in negative emotions (Young et al., 2012), which could explain the physical feelings these students are experiencing as described by the participants. Research has found that it is not uncommon for math anxious students to experience bodily changes such as stomach-aches and increasing heart rates during math class (Faust, 1992; Ashcraft, 1995). The literature and participants’ experiences demonstrate how math anxiety does not only impact students’ emotional wellbeing but also their physical wellbeing.

4.1.2 Math educators recognize that certain behavioural, verbal and emotional indictors of math anxiety can be more subtle and difficult to detect.
While all participants observed students show overt signs of math anxiety they also observed more subtle behaviours that can be connected to math anxiety. These signs were described by the participants as being less clear because they could be confused with other problems the student is experiencing. Angela believes that some students do not want their teacher and classmates to know they have math anxiety so they try to hide it making them show less obvious signs of math anxiety. She has seen students who appear to be fine during day to day math activities but shut down when they are required to do some sort of assessment activity. Also some students with math anxiety will take longer to complete an assignment or will be unable to finish because they are too concerned with putting “the right things” down on paper. The problem with these less obvious signs is that they could be confused with a student having lower math ability.

Megan has also observed students show signs of “perfectionism” caused by math anxiety. She has had students who take excessive amounts of time to complete a math question because they are afraid of making a mistake. She has also observed students with math anxiety comparing their math ability to others harming their self-confidence and their ability to learn in math class. She believed that many students with math anxiety have the mental mindset of “I just can’t do this” and often this mindset is kept to them selves because they are worried what others will think.

Cathy also believes that students with math anxiety have a lack of confidence in their own abilities. She claims that sometimes a student’s mindset is more obvious where at other times it is difficult to see. She has had students who are afraid to come ask for help because they are worried about what other students will think. Even during group work activity math anxious students will quietly avoid doing math by letting their partner take over. This behaviour is not
always easy for teachers to observe because they are not causing any disruptions in the
classroom or trying to seek help. This behaviour makes it difficult for teachers to detect whether
a student has math anxiety or is just struggling in math for other reasons such as learning
disabilities or gaps in their learning.

Similar to what these teachers observed the literature also found that many students with
math anxiety have very little confidence in their math ability. This mindset is harmful to student
success because not only does it prevent them from persevering but also can consume most of
their working memory making it difficult to solve multistep problems (Beilock et al., 2004;
Jansen et al., 2013). Additionally, scholars have studied the long-term impacts of math anxiety
and have seen that if left untreated it could negatively impact a student’s math ability and career
path (Ashcraft & Moore, 2009). This finding shows how it is crucial for teachers to be aware of
what math anxiety can look like so they can help their math anxious students especially since
students do not always show obvious signs.

4.1.3 Math educators recognize that indictors of math anxiety can arise in a variety of
situations in the math classroom.

All three participants have seen math anxiety occur in several different situations in the
classroom. Each participant has observed students showing math anxious behaviour while doing
an assessment. Cathy mentioned more specifically how she has observed the EQAO testing
negatively impact students with math anxiety. She believes that the EQAO testing places a lot of
pressure on students to perform when some of them, especially students in grade three, may not
be developmentally ready for some of the math problems on the test. She also expressed concern
at the way teachers are required to cover all areas of the math curriculum quickly in order to
prepare students for the test, leaving less time for students who need more time to grasp concepts.

Like these teachers, researchers have also noted that math anxiety can occur in a variety of situations even outside of school when both children and adults are faced with having to solve a math problem (Ashcraft, 2002; Ashcraft & Krause, 2007; Jameson, 2014). This connection between the literature and participants’ experienced shows that math anxiety can exist in different places and even beyond the classroom.

4.2 Math Educators Believe that Math Anxious Students Benefit from a Positive Classroom Environment Where They are Given Individualized Attention and the Opportunity to Learn Math in a Way That Increases Their Conceptual Understanding.

All participants believed that teachers play an important role in recognizing the signs of math anxiety and also feel that teachers play an important role in helping students overcome math anxiety. These teachers use several different strategies to address and prevent math anxiety in the classroom. Although they have different pedagogical philosophies, all participants agree that classroom environment and teaching methods greatly influence student anxiety in math class. They also believe that the best thing they can do to assist their math anxious students is observe their behaviour and work with them one on one to address the issues that they identify. These strategies have been very helpful to these teachers towards addressing math anxiety in their classrooms.

4.2.1 Math educators believe that focusing on conceptual understanding when teaching math is more beneficial to students with math anxiety.

All three participants were able to speak to the sharp contrast between the type of math instruction they experienced when they were in school compared to what is being promoted now
for teaching math in schools. In the past, math involved more memorization of steps and procedures, whereas now students are encouraged to develop their own problem solving skills through “explore” type activities.

Angela and Megan both agreed that the way math is being taught differently now has benefited all of their students including those with math anxiety. Last year Angela worked with a teacher who had several math anxious students in her class by helping her introduce a Context for Learning Kit on multiplication to her class. These kits include lessons and materials that help students learn through context and problem solving to give them a deeper understanding of the math concept they are working on. She was amazed to see how engaged these students were when they were working with the kit. She felt that the kit increased students’ motivation and confidence in math, which helped alleviate some of the anxiety they were feeling towards the subject.

Megan also observed similar results from her students when she taught them math through problem solving. She noticed that when she gave students more choice in math class—whether it was in how they solved the math problem or what activity they worked on—they showed less signs of anxiety. Megan also placed a lot of emphasis in her classroom on growth mindset, the idea that making mistakes helps us learn and grow. She shifted the focus in her class by continuously reinforcing to her students that “it is not about remembering a procedure but making sense of it”. Megan has seen this idea have a tremendous impact on students with math anxiety, especially those who have perfectionist tendencies. She also observed that her math anxious students were less nervous to raise their hand and speak in math class because they no longer had to be fearful about having a perfect answer.
Like Angela and Megan, Cathy sees value in reinforcing growth mindset in the classroom and increasing students’ conceptual understanding. However, she questions whether open-ended questions and assignments are beneficial to students with math anxiety. In her experience she has found that asking, “how would you solve this problem” has increased her math anxious students’ anxiety because they do not know where to start. She believes that explicit instruction and reviewing steps is necessary to helping students feel successful in math.

Similar to what Angela and Megan described observing in their own classrooms, researchers also noticed that increasing student’s conceptual understanding in math is essential to math anxious students’ success (Beilock et al., 2004; Ashcraft & Krause, 2007; Parrish, 2011; Ramirez et al., 2013; Boaler, 2014). Although conceptual understanding can be achieved in different ways one of the more effective methods is through open-ended tasks and practices that value different ways of thinking such as number talks (Parrish, 2011; Boaler, 2014). Scholars have also observed that math anxiety was higher in classrooms that valued performance over mastery (Turner et al., 2002; Ashcraft & Krause, 2007; Boaler, 2014). This may be a reason why participants found the growth mindset benefited their students with math anxiety. Growth mindset emphasizes mastery over performance because it values mistakes and perseverance as an important part of learning. Both the participants’ responses and research findings show how classroom atmosphere and teaching styles can have a significant impact on students’ math anxiety.

4.2.2 Math educators found that conferencing and working one on one with math anxious students benefited their sense of confidence and ability in the classroom.

Angela described the way teachers should be towards students as a “math nurturing mother”. She believes that it is important for math anxious students to receive individualized
attention to help them overcome their anxiety. She recommended that teachers begin helping students who they feel are at risk by closely observing them to see what is causing the anxiety. For example, through observation and conferencing with one of her students she learned that the students’ math anxiety was caused by a fear of being wrong on paper especially during assessments. From this new discovering Angela was now able to modify her instructions to better suit the needs of her student. Instead of having her write math tests using a pencil and paper she had her write her solutions on a white board and when she was finished Angela would take a picture of the whiteboard for her reference.

Megan and Cathy also mentioned how they use their students’ feedback to guide their instruction in math. Megan claimed, “I firmly do believe that every student, certainly in primary, can learn math.” Both teachers emphasized the benefits of close observation and working one on one with students to address their anxiety and improve their confidence in math. One of the strategies that Megan uses when working one on one with her math anxious students is breaking math problems into smaller pieces so that the problem will seem more manageable.

Scholars who have studied math anxiety found that it was more beneficial for students to study math that is at their own level because doing so will naturally increase their ability and confidence (Jansen et al., 2013). By working one on one with these students the participants are adapting instruction to meet the needs of their students, which may explain their increase in understanding of math concepts and, in turn, their confidence. Research also suggests students tend to practice math more often when they feel successful (Jansen et al., 2013). When these teachers break questions down and modify their assessments they are allowing their students to experience success in math. These findings confirm the value in one on one instruction and observation in the classroom for supporting students with math anxiety.
4.3 Even Though Number Talks are a School Board Initiative, Math Educators Also Include Them as a Part of Their Math Program Due to Positive Feedback From Students and Their Own Personal Pedagogical Positioning.

Although participants found it beneficial to work with math anxious students individually, they also believe that number talks benefit not just all their students but also students experiencing math anxiety. Number talks are short conversations where students are presented with a math problem and then encouraged to solve the problem using mental math strategies that work best for them before sharing their solutions with the class (Parrish, 2011). These teachers explained that they use number talks because of the positive feedback they receive from their students both academically and emotionally. These teachers discussed how their students genuinely enjoy doing number talks and sharing their strategies with the class. Teachers also used number talks because, even though each participant had different teaching styles, they felt that number talks fit very well in their math programs. More specifically, these teachers use number talks because they believe it benefits students with math anxiety. They multiple benefits of number talks make them a widely used math practice in these teachers’ classrooms.

4.3.1 Math educators include number talks as part of their math program because they observe that students enjoy doing them.

As discussed in the previous section, the participants of this study found it beneficial to use feedback from their students to guide their instruction. Accordingly, all teachers used number talks because they were received very positively from their students. For example, on the last math class of the year, Angela’s Grade 4/5 class requested that they do one last number talk. She explained how good she felt receiving such positive reactions towards number talks from her
students, “it is very cool when kids want to do it, and you know that what you have done has value.” She felt that students enjoy doing number talks because they are an interactive activity where every student has the opportunity to participate in a safe way. Megan also noticed that her students enjoyed doing number talks during math class and that number talks created a safe space for her math anxious students to participate. She believed this was because during her number talks she made sure that her students saw mistakes as valuable learning opportunities.

Cathy has found that although her students benefit from doing number talks they begin to feel bored of them if she does them too often. The school board this teacher is working in recommends doing number talks often during each week. But she feels that this recommendation is not practical due to timing, the need to cover other math strands, and her students’ attention spans.

While there is plenty of research on the benefits of number talks on student success, there is little research that explains how students feel about doing number talks. Most of the research discusses how students benefit academically from number talks because it improves their comfort and fluency in number sense (Parrish, 2011; Richardson, 2011; Boaler, 2016). Although it could be assumed that students enjoy number talks because they make them feel successful there is no explicit research that connects number talks and student enjoyment. The participants’ experiences suggest that generally students do enjoy doing number talks when they are not used too often. Their observations suggest that teachers, administrators and researchers need to look different ways to do number talks to make them more engaging to students.

4.3.2 Math educators use number talks in their classroom because they believe that they prevent math anxiety and benefit students who are experiencing math anxiety.
All three participants observed that their math anxious students tended to avoid participating in class. They claimed that their lack of participation was caused by a fear of being wrong in front of their teacher and peers. Angela explained that when number talks are done properly they can provide a safe space for these students to participate. One of the strategies that the participants use in their classrooms is called a “quiet thumb”. Instead of raising their hands when they have something to share students will quietly place a thumb to their chest. Angela describes the benefits of this strategy:

There isn’t any of that anxiety where you ask the group of kids a mental math question and you’ve got three kids who have already put their hands up in the first three seconds that you have given them the question those other kids immediately shut down, they think oh my gosh I’m not as smart as them, I’m never going to be able to answer this question because I can’t do it as fast as they do. So as soon as you eliminate the hand raising and it’s just a private thumbs up you automatically increase think time for all the kids.

Angela explains that number talks do not always come naturally to the students making it up to the teacher to reinforce beneficial practices and create a safe classroom environment.

Megan also feels that number talks benefit students with math anxiety because they create a safe space for students to participate. But she also believes they benefit all students because of how they break down the math problems. She believes that “one of the best approaches when it comes to math anxiety for me is to break the math down into smaller pieces, make it more manageable and number talks have the ability to do that.” When students are sharing their thinking they are breaking their ideas into smaller steps making the questions seem more manageable to students with math anxiety. She notices that sometimes her math anxious students are only able to get the first part of the problem but seem to be able to follow along and
benefit from their classmates’ strategies. However, being able to get the first part of the question allows them to have little successes in math class.

Cathy explains how it is these strategies that math anxious students hear from their peers that can lessen their anxiety. Number talks show that there are multiple different ways to solve math problems and that students should solve problems in ways that make sense to them. Giving students this feeling of control can reduce some of the anxiety they feel when faced with a math problem. Cathy also makes anchor charts with the different strategies students use during number talks, giving something for math anxious students to refer to during math class.

Similar to what these teachers notice in their practice, research also shows that number talks can benefit students with math anxiety. Many students have seen math as a fixed subject because of the narrow, procedural tasks that are often used in math lessons (Boaler, 2014). Students with math anxiety will struggle even more in classrooms that use lots of narrow, procedural tasks because their working memory will be consumed by stress for solving the problem in the right way (Turner et al., 2002; Beilock et al., 2004). Number talks provide an opportunity for students to see math as an open subject and are done in a low stress environment, both of which benefit math anxious students.

4.3.3 Math educators use number talks in their classroom because they align with their personal pedagogical beliefs and benefit their students’ learning.

Although each of the teachers interviewed had differing opinions on the way math should be taught, number talks seemed to align with their differing approaches. Angela described her teaching style as being influenced by constructivism, the belief that students learn better when they create and build their own knowledge. She values number talks because of the way they empower student to come up with their own strategies that make sense to them. Megan explained
how she uses a lot of math games, manipulative, number talks and mini lessons. Cathy uses similar teaching strategies to Megan, but also believes that students, especially those who struggle, need lots of examples and explicit instruction.

Megan explained that she uses number talks in her classroom because she values students’ individual ways of thinking. She said:

I’m often amazed by their abilities and how they look at numbers so I think it’s incredibly valuable in that regard, and I think for kids to see that people see things differently, not just one way, it empowers students and that is tremendously valuable. She has observed an amazing difference in her students’ ability to communicate their thinking and reason why one strategy is more beneficial than another in a certain situation. Megan explains that sometimes during number talks her students make her have “ah ha” moments herself when they explain a new strategy that she has not see before.

Similar to Megan, Cathy also uses number talks because it helps students to develop their number sense and reasoning skills. She finds number talks helpful for building number sense strategies with her students, which are then put on anchor charts for their reference. When she uses number talks in her math program, Cathy sees an improvement in her students’ mental math skills. She believes that mental math is very important because it is a skill that students will use their whole lives.

The literature reviewed for this paper did not discuss the influences of teachers’ pedagogies on their opinion of number talks. Research on number talks tended to focus on how they should be carried out in math class and how students benefit from them academically. The teachers’ interviews all had positive opinions on number talks because they felt that this teaching practice enhanced their math program by being engaging to students and increasing their
students’ success in math. These teachers show that academic and emotional outcomes from students greatly influence what they include in their programs. Although there is curriculum that teachers must abide by they have the ability to choose how that curriculum is taught to their students. For this reason with any new practice it is important to consider how teachers will receive it and incorporate it into their classroom routine. It would be interesting to hear from the perspective of a teacher who feels they do not align with their math program to see if that is a barrier to using number talks in the classroom.

4.4 Math Educators Face Challenges Related to Number Talks With Their Math Anxious Students and Non-Math Anxious Students, Which They Overcame by Conferencing with Students, Monitoring Participation and Maintaining Classroom Norms.

With any new teaching practice there are negatives and positives. While the participants have experienced lots of positive outcomes from number talks they have also experienced some challenges. Although the participants see number talks as beneficial, they do not always have enough time to do them as frequently as they would like due to other curricular demands. Another challenge that all participants experienced in different regards is participation from their students, specifically those who are math anxious. Teachers also experienced challenges with her students’ behaviour during number talks making it difficult for them to be done in a way that benefited all students. Despite the difficulties these teachers experienced during number talks they were able to use a variety of strategies to overcome these challenges including monitoring participation, allowing them to work in pairs, conferencing and maintaining classroom norms.

4.4.1 Math educators experience challenges with student participation, behaviour and not having enough instructional hours in the day.
All participants discussed having challenges with participation during number talks from both their math anxious students and non-math anxious students. They found that, because of the emphasis placed on increasing students’ comfort level, by allowing them to participate when they choose, many students would not participate. Angela described this challenge as a “balancing act” because she wants to encourage students to participate but does not want to push them too hard and increase their anxiety in math.

Megan also found it difficult to encourage her math anxious students to participate and found that sometimes other students’ behaviour during number talks made it difficult to have a safe space. She found that some of her students who were more procedurally fast in math would not follow the “quiet thumbs” rule but would instead call out the answers. Megan found this harmful to her math anxious students who needed more time to think and process before sharing. When students would call out their answers she would see her math anxious students shut down and not try to participate.

Cathy also had problems with behaviour during number talks but felt that having enough time to do number talks was more of a challenge in her classroom. She found that she was not able to do number talks as often as she liked because of time constraints and the need to cover other curricular areas. Also she mentioned that even though they are meant to be a short activity they often go a lot longer than the time she allotted. They generally go longer for two reasons; firstly, she wants to give lots of different students an opportunity to share their answer, and secondly, sometime it takes a while for them to get the strategy she is looking to teach.

There has been little research collected on the challenges of number talks because they are a relatively new practice that is increasingly becoming popular in school boards. However, Parrish (2011) and Boaler (2014) discuss how number talks and other more open math tasks may
be difficult for students at first, especially students who are used to doing a lot of procedural work. The participants in this study did not mention their students having difficulties with doing the actual math in a number talk. Instead they noticed more challenges with student behaviour and timing. This disconnect from the research shows that teachers could encounter a variety of different challenges depending on the students in their classroom.

4.4.2 Math educators use a wide range of strategies including conferencing and modifying to respond to the challenges they experience during number talks.

Being experienced math teachers, the participants were able to recommend different solutions to the challenges they have experienced during number talks. Angela’s goal for her number talks is to ensure that all of her students participate at least once each week. To keep track of who has participated, Angela keeps a running record of who has participated and who has not. Midway through the week she will speak with students one on one asking them if they would be comfortable participating in the next number talk. Angela also found it beneficial to give her math anxious students a “heads up,” even providing them with the math problem in advance.

Cathy also responded with different solutions to help math anxious students feel more comfortable participating. She found using mini whiteboards with her students to be really beneficial for encouraging students to participate. She also would sometimes allow students to work in partners or do a “think-pair share” before sharing their answer. Using these strategies benefited her math anxious students because it made them feel more comfortable and supported during number talks.

Megan used similar strategies for encouraging more participation from her math anxious students. But she also used several strategies to ensure students were following the classroom
norms for number talks so that all of her students would feel comfortable participating. She said, “even though it sounds all wonderful and you have the rules in place, sometimes it’s hard to prevent those students from calling out. And when they call out they take the learning away from other students and it defeats the whole purpose of a number talk”. Megan responded by this challenge by reviewing the classroom norms with her students and having discussions with them about why these norms are put in place whenever she felt it was necessary. She would also have private discussions with students who were frequently calling out to see what was causing their behaviour and how they could prevent it from happening again.

Since there is little research on the challenges teachers experience during number talks there is also little research on the solutions teachers can use to resolve challenges. This could be because number talks are a relatively new practice that is becoming increasingly popular in schools. The participants’ experiences show that for them one of the best ways to address challenges is through one on one conferencing and making modifications that better suit the needs of students. However each teacher discussed different challenges and solutions demonstrating that teachers will face a variety of challenges depending on the students in their classroom. Having more information about the different challenges and solutions teachers experience could help better support teachers with using number talks in their classroom.

4.5 Math Educators Use a Variety of Resources When Designing and Implementing Number Talks Including Support Staff in the School, Online Resources and Board-Developed Resources.

Since number talks are a board initiative, participants found that there was an abundance of resources available to help them teach number talks to their students. Angela, being a school math specialist helps other teachers feel more confident teaching math. She provides teachers
with extra help by modelling number talks for them, providing them with helpful advice and
directing them to further resources. She recommends that teachers who need new ideas or extra
help read Sherry Perrish’s book *Number Talks: Helping Children Build Mental Math and
Computation Strategies*. This book goes through the process of setting up number talks in the
classroom and provides different purposefully designed number talks that teachers can use in
each grade level. She also recommends that teachers who need extra support attend any
professional development that the boards make available.

Megan and Cathy were first introduced to number talks during a professional
development day. From there they have drawn on a lot of other resources that are located in their
schools. Both teachers have used math coaches to support them teaching number talks. Megan
describes her experience working with the math coach:

She is amazing, I feel very fortunate to have her in our school, she’s got great ideas, she
comes with years of experience and again we have touched upon that enthusiasm! She is
so enthusiastic about math that it is contagious, it makes me feel better in math and it
makes me perform better in the classroom.

Megan strongly encouraged teachers, especially new teachers, to connect with other teachers in
the school for more support and resources. She also recommended specific resources from
teachers to read, including books by Marian Small, and accessing a website called “youcubed”
by Jo Boaler. While there are a lot of resources out there, both Megan and Cathy admitted they
sometimes found it challenging to find the time to go look for them and read them.

While there are plenty of resources available to teachers there is little research that
discusses the benefits of using these resources. However it can be assumed that teachers do
benefit from reading the work of prominent scholars in the field such as Marian Small, Sherry
Parrish and Jo Boaler because all of these women have worked with classroom teachers and students to see what practices benefit students’ math ability. The participants also mentioned how they use other resources such as in school support staff and websites to help them teach number talks and support students with math anxiety. This shows that there are a variety of resources available to teachers that can suit their preferred learning style. Overall these teachers show that accessing resources is beneficial to their practice and comfort level with teaching number talks. People working in the field of education could benefit from more research being done on how resources can be designed to better suit the needs of teachers.

4.6 Conclusion

In this chapter I organized my findings into five main themes that discuss how teachers use number talks to support students with math anxiety in the classroom. Teachers observe many different signs of math anxiety for their students, showing that it is an issue that teachers must be made aware. These teachers also have several different strategies for helping students with math anxiety. One of the strategies they believe is beneficial to students with math anxiety are number talks. According to the participants and literature number talks help students build mental math and reasoning skills while also providing multiple strategies for students to use when solving math problems. With any new practice there will always be challenges both for the teachers and students. However, these experienced teachers provided many different practical strategies for overcoming these challenges. In addition to the current research these teachers have found that there is a connection between number talks and math anxiety in their classroom. They have observed that when number talks are done well they can benefit students with math anxiety by giving them more confidence in their math ability. They have also discussed how number talks are more engaging to students when they are not done the same way all the time. These teachers
have also pointed to gaps in the literature, showing how there is a lack of research around designing helpful resources for teachers. In the next chapter I will discuss the implications of my research and share any further recommendations for the educational community.
Chapter 5: Conclusion

5.0 Introduction

In this chapter I will give a brief overview of my key findings and describe their significance to the educational community. Next I will discuss the implications of these findings for both the educational community and myself as a teacher researcher. From there I will then make recommendations for teachers and school boards based on my findings. Lastly I will outline possible areas for future research on the topics of math anxiety and number talks.

5.1 Overview of Key Findings and their Significance

In the previous chapter I organized my findings into five different themes that examined the relationship between number talks and math anxiety. The themes explain how students show math anxiety through several different behaviours and that there are several strategies teachers can use to support students with math anxiety. They also explain that number talks are believed to benefit students with math anxiety and there are several challenges associated with number talks and math anxiety. The information gathered from interviewing three experienced teachers shows that it is important for teachers to closely observe their students so that they can support their students with math anxiety and one way they can do this is through number talks.

The three teachers interviewed for this study all believe that certain aspects of number talks benefit their students with math anxiety. Number talks stress the importance of increasing students’ think time through strategies such as wait time before selecting a student to share and using “quiet thumbs.” Number talks also stress the importance of allowing students to construct their own knowledge, make mistakes and learn from them. This means that during a number talk the teacher assumes more of a facilitator role, allowing the students to take control of their learning. These teachers believe that using these strategies during a number talks makes the
classroom environment a safe space where students can participate meaning that number talks are beneficial to students with and without math anxiety.

Even though number talks have many benefits, these teachers have experienced several challenges while using them as part of their math program. These include challenges with participation, especially with students who are math anxious, behaviour challenges and issues with having enough instructional time to teach curricular content. These challenges make it difficult for teachers to do number talks consistently. However, these teachers have discovered numerous strategies that help alleviate these challenges such as modifying their instruction, conferencing with students and reviewing classroom norms. Overall these teachers believe that their students genuinely enjoy using number talks and that they benefit academically. Their experiences show the importance of including number talks in any math program.

5.2 Implications

In this section I outline the implications of my research for both the educational community including teachers, school boards and administrators and myself as an educational researcher and new teacher.

5.2.1 The educational community

The literature on math anxiety along with the participants’ experiences suggest that math anxiety is a common issue that needs to be addressed by teachers, administrators and school boards. All three participants have witnessed the negative effects math anxiety can have on a student’s confidence and ability in math. Students who suffer from math anxiety often have little confidence in their math ability preventing them from persevering through more difficult problems. This mindset can cause them to fall behind impacting not only their performance during school but also in their adult lives (Ashcraft & Moore, 2009). Although there are many
proposed solutions in the literature the participants in this study believe that number talks are an activity that teachers can use to support students with math anxiety. Once of the reasons they can support students with math anxiety is because they provide a safe space for students to participate. Math anxious students will also benefit because during number talks students are encouraged to break down the math problems into smaller more manageable pieces. Number talks also show students that there are multiple ways to solve a problem. This can lessen students’ anxiety because it gives them control, allowing them to solve a problem in a way that makes sense to them rather than how the teacher told them.

While number talks could seem like an instructional approach that would be difficult for math anxious students because they involve participation, these teachers’ experiences show that number talks can benefit students with math anxiety. Even though these teachers recognize that every student is different they have discovered some strategies that can benefit students with math anxiety during number talks. For example, Angela recommends that teachers keep a running record to keep track of the students who have participated during a number talk. Closer to the end of the week Angela will conference with students who have not yet participated encouraging them to participate in the next number talk. One of the other participants, Cathy found that her math anxious students were more engaged when she allowed them to use mini white boards or work with a partner during their number talks. Megan whose class had a difficult time with behaviour found it beneficial to consistently review and enforce classroom norms. These teachers’ experiences show how important it is for teachers to know their students so that they can tailor their instruction specifically to their needs. They also demonstrate the value of taking risks and trying new practices in the classroom because of the way they can improve student’s experiences at school and their academic ability.
While the pressure remains mainly on teachers to integrate number talks in their math programs it is important for school boards and administrators to support teachers integration of new practices. The participants discussed the importance of having access to resources meaning it would be beneficial for school boards to provide more resources on number talks for teachers to use in their classroom. These resources should be easily accessible, affordable and practical. It was also found that administrators can better support teachers by giving teachers opportunities to attend workshops, giving them release time to plan with math experts and more opportunities to plan with teaching partners. These are a few actions mentioned by the participants that assisted them in better implementing number talks in their math programs.

5.2.2 My professional identity and practice

Before coming into the Master of Teaching program at OISE I was very nervous about the prospect of teaching math. I was nervous for two reasons, firstly because math is such an important part of the curriculum and secondly because I have never felt confident in my own math abilities. This research paper has helped me overcome my fears of teaching math because, through researching and speaking with experienced teachers, I have developed a new understanding of what it means to teach math in twenty-first century classrooms. There is more of a focus on building students’ conceptual understanding of different math ideas, and research states that students benefit conceptually in math when they are given opportunities to construct their own knowledge (Boaler, 2015). During the interviews all of the teachers discussed how there is a movement to encourage students to think with a growth mindset. Teachers can do this by encouraging students to take on new challenges and not be afraid of making mistakes. This focus on constructivism and growth mindset in the math classroom takes a lot of pressure off of teachers who are not confident in their own math ability like myself, because it shows that it is
okay to make mistakes and ask questions because it is good to model this behaviour for students.

Number talks are an instructional activity that encourages students to construct their own knowledge, deepen their conceptual understanding of numbers and relationships, and maintain a growth mindset. For these reasons I plan on using number talks very often in my classroom. Most of the teachers during the interview process explained how they believed number talks fit best into their math programs when they were teaching number sense. They claimed that they used them less during other strands such as geometry or data management. However, I believe that certain aspects of number talks, such as the quiet thumbs and sharing multiple solutions, can be used in all math strands and even other areas of the curriculum. I look forward to the opportunity to be able to use these strategies in my future classroom and observing how my students benefit both academically and emotionally.

5.3 Recommendations

In this section I make recommendations for teachers and school boards based on my research about number talks and math anxiety. These recommendations will show how teachers and school boards can further support students with math anxiety and support teachers using number talks in their classrooms.

5.3.1 Teachers

- It is important that teachers closely observe their students’ behaviours in math because math anxiety comes in a variety of forms that are not always easy to detect
- Teachers need to be aware that math anxiety tends to arise during high pressure situations such as during assessments and timed activities
- Teachers can increase their students’ growth mindset by creating a classroom atmosphere where mistakes are valued
Teaching students math through context and problem solving will give them a better understanding of the math concept they are working on and increase their motivation and confidence in math.

Giving students choice in math for example in how they solve the problem or what problem they choose to solve will help alleviate anxiety in math.

During number talks it is important that teachers continuously reinforce classroom norms so that all students feel safe participating.

Teachers should allow students to work through math problems in a way that makes sense to them.

5.3.2 School boards

School boards need to provide teachers with resources to support teachers teaching number talks.

These resources need to be easily accessible for teachers and this can be done by purchasing resources for individual teachers or grade teams.

It is helpful for teachers to have access to a math coach.

Math workshops are beneficial when they connect to the grade level and curriculum areas the teachers are teaching.

5.4 Areas for Further Research

Although the literature on math anxiety is fairly comprehensive, more research needs to be done on number talks and diverse ways to teach math to students with math anxiety. More specifically, there is a gap in the research around how these teachers integrate diverse teaching practices in the classroom and how students respond to different teaching practices. The literature discusses how students with math anxiety benefit from a more supportive teaching
style and classroom environments that value effort over final product (Turner et al., 2002; Ashcraft et al., 2007). However, there is little research that states what teachers can do specifically in their classroom to create these kind of positive environments.

Another area in the research that can be improved on is resource development for teachers. This gap in the research was illuminated by one of the participants in this study who explained that she seeks out resources that are practical and have strategies that could be easily implemented in the classroom. It would be beneficial for more research to be done in the area of resource development. It is crucial that teachers take part in this research on resource development because they are the people who are going to benefit from these resources.

5.5 Concluding Comments

This chapter began with an overview of the key findings of my research on math anxiety and number talks. After interviewing three experienced teachers and reviewing current literature on number talks and math anxiety it is clear that number talks are an instructional practice that can benefit students with math anxiety. It was also discovered that teachers might come across difficulties with student participation and behaviour and having enough instructional time to do number talks. However, because of the benefits number talks have on students’ confidence and achievement in math it is important to find time to include them in a well-rounded math program.

Next, this chapter discussed the implications that my research will have on the educational community and my own development as a teacher researcher. From my research, the educational community will know that math anxiety is an issue that many teachers will encounter during their teaching careers. They will know that math anxiety has a detrimental impact on students’ confidence and ability in math. They will also know that teachers play an important
role in supporting students with math anxiety. The implications for the educational community also connect to my personal implications as a future teacher.

The implications of this research project have given me the ability to make several recommendations for teachers and school boards. These recommendations focus on what teachers can do to support students with math anxiety and what school boards can do to support teachers teaching students with math anxiety. My recommendations also include actions that school boards can take to support teachers with integrating number talks in their classroom. These recommendations are important because number talks are a relatively new approach meaning that not all teachers will feel confident using them without some sort of support. This support can come from board-developed resources, electronic resources and math specialists.

This research project has improved my understanding of different instructional approaches in math that can benefit students with and without math anxiety. They have made me more confident in my own ability to teach math and have allowed me to develop a list of recommendations for teachers and school boards. This research study has also shown that even though there is very comprehensive amount of literature on math anxiety and teaching math in general there is still areas that need further research. Despite this my research has shown that math anxiety is an issue that needs to be addressed in Ontario classrooms to further support student achievement and confidence in math. Additionally my research has shown that there is several strategies teachers can use to support students with math anxiety, one of these strategies being number talks. These findings are important because they can help teachers feel more confident with teaching math to students with math anxiety.
References


Appendix A: Letter of Consent for Interviews

My Name is Rachele Webb and I am a student in the Master of Teaching program at the Ontario Institute for Studies in Education at the University of Toronto (OISE/UT). A component of this degree program involves conducting a small-scale qualitative research study. My research will focus on how elementary school teachers use number talks in the classroom to support students with math anxiety or are at risk of developing math anxiety. I am interested in interviewing teachers who specialize in mathematics and frequently use number talks in their classroom. I think that your knowledge and experience will provide insights into this topic.

Your participation in this research will involve one 45-60 minute interview, which will be transcribed and audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient for you, outside of school time. The contents of this interview will be used for my research project, which will include a final paper, as well as informal presentations to my classmates. I may also present my research findings via conference presentations and/or through publication. You will be assigned a pseudonym to maintain your anonymity and I will not use your name or any other content that might identify you in my written work, oral presentations, or publications. This information will remain confidential. Any information that identifies your school or students will also be excluded. The interview data will be stored on my password-protected computer and the only person who will have access to the research data will be my course instructor Angela MacDonald. You are free to change your mind about your participation at any time, and to withdraw even after you have consented to participate. You may also choose to decline to answer any specific question during the interview. I will destroy the audio recording after the paper has been presented and/or published, which may take up to a maximum of five years after the data has been collected. There are no known risks to participation, and I will share a copy of the transcript with you shortly after the interview to ensure accuracy.

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

Sincerely,
Rachele Webb
rachele.webb@mail.utoronto.ca

Course Instructor’s Name: Angela MacDonald
Contact Info: angela.macdonald@utoronto.ca

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

Signature: ______________________________________

Name: (printed) _______________________________________________

Date: ______________________________________
Appendix B: Interview Protocol/ Questions

Introductory Script: Thank you for agreeing to participate in this research study, and for making time to be interviewed today. This research study aims to learn how number talks impact students who have or are at risk of math anxiety for the purpose of informing future teaching practices. This interview will last approximately 45-60 minutes, and I will ask you a series of questions focused on your own experiences teaching mathematics to elementary aged students. I want to remind you that you may refrain from answering any question, and you have the right to withdraw your participation from the study at any time. As I explained in the consent letter, this interview will be audio-recorded. Do you have any questions before we begin?

Background Information

1. How many years have you been working as a teacher?
2. What grades and subjects do you teach currently? What grades and subjects have you taught in the past?
3. In addition to your role as a teacher, do you fulfill any other roles in the school?
4. Have you completed any additional training in mathematics education?
5. Why did you decide to focus on mathematics?
6. How often do you use number talks in your classroom?

Teacher Perspectives/Beliefs

7. How would you describe math anxiety?
8. Why do you think students experience math anxiety?
9. Do you feel that math anxiety is a major issue with students in today’s classrooms?
10. Why do you choose to use number talks in your mathematics program?
11. How do you feel about the way math is currently being taught in schools?
12. Do you believe that number talks and similar instructional approaches benefit students with math anxiety?

Teacher Practices

13. What behaviour patterns do you observe from students who are suffering from math anxiety? Would you say that these signs are very obvious?
14. How do you respond to students who are showing signs of math anxiety? Can you give me specific examples?
15. What instructional strategies do you feel are most effective for responding to students with math anxiety?
16. What factors do you take into consideration when designing number talks?
17. What specific strategies do you use during number talks to engage learners who are showing signs of math anxiety?

Supports and Challenges

18. Have you received any extra training in designing and executing number talks? If yes, do you feel this training was satisfactory?
19. What resources do you use when designing number talks? Would you recommend these resources to beginning teachers? Why?
20. What challenges have you experienced during number talks specifically with math anxious students? How do you respond to these challenges?

Next Steps

21. What advice do you have for beginning teachers who will likely encounter math anxious students?
22. What advice do you have for teachers who may not feel comfortable doing number talks in their classroom?

Thank you for your participation in this research study.