Do-Re-Mi, One-Two-Three: Integrating Music into Math Program Delivery to Address Math Anxiety

By
Kathryn Bryce

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

The present qualitative research study examines the question: Can the integration of music into teachers’ math programs help to address math anxiety for learners and teachers? Data was collected through semi-structured interviews with two Ontario Certified Teachers working in the Greater Toronto Area who integrate music into their math program delivery, contacted through convenience sampling. Interview transcripts were read numerous times in order for themes to emerge. These emergent themes were organized into four main themes: Factors influencing the use of music in the math classroom, How music is used in the math classroom, Music’s perceived effect on students in the math classroom, and Supporting learners with math anxiety. Implications for the education community and personal practice are discussed, and recommendations are made for pre- and in-service teacher training to increase the integration of music into teachers’ math programs.

Key Words: Math anxiety, music, arts integration
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Chapter 1: Introduction

1.0 Research Context

The subjects of mathematics and music may appear to have little in common. Mathematics is a discipline involving logic and problem solving; music is one of emotions, listening experiences, and human connections. A more in-depth look, however, reveals the mathematical principles that lay the foundation for much of music: proportion, fractions, common multiples (Bamberger & diSessa, 2003), patterning and spatio-temporal reasoning (Johnson & Edelson, 2003). Even the music of Ludwig van Beethoven can be examined and explained using a mathematical lens. The underlying mathematics of Beethoven’s Moonlight Sonata reveal the patterns created by sound waves, and how Beethoven used those patterns to compose such a moving piece of music (St. Clair, 2014).

1.1 Research Problem

Many people, however, view math only as the study of numbers, and often perform poorly and dislike it (Suri, 2013). Ontario students’ performance on the Education Quality and Accountability Office (EQAO) assessment of mathematics has been steadily decreasing over the past five years, with only 67% of Grade 3 students and 54% of Grade 6 students at or above the provincial standard (EQAO, 2014). Students’ attitudes towards mathematics are even more disheartening. Over the past five years, only 53% of female Grade 3 students responded “Most of the time” to the statement “I like mathematics,” compared with 62% of male Grade 3 students (EQAO, 2014). By Grade 6, these figures have fallen to 41% of female students and 55% of male students. Furthermore, only 30% of females in Grades 3 and 6 feel they are able to answer difficult math questions most of the time, compared to 44% for grade 3 males and 46% for grade 6 males (EQAO, 2014). This data shows that Ontario students not only perform poorly in
mathematics, they do not enjoy it nor do they feel confident in their abilities. Female students’ attitudes in particular are troubling. Because of the inherent connections between mathematics and music, the present study will examine whether or not a mathematics program that integrates music is able to play a role in addressing student—and teacher—attitudes toward math.

Throughout this research paper I will use both “music-integrated math program” and “music-infused math program” to refer to a classroom teacher’s incorporation of the deep connections between mathematics and music to teach mathematics in their classroom, such as examining proportions using note value. This is in comparison to a math lesson that simply involves a song about fractions.

1.2 Purpose of the Study

Math anxiety is a learned behaviour (Hembree, 1990), stemming from the method of mathematic program delivery (Geist, 2010). Importantly, teachers who suffer from mathematics anxiety are likely to pass it on to their students (Geist, 2010). Hembree (1990) reports that math anxiety can be diminished through cognitive restructuring of faulty beliefs and self-confidence, combined with relaxation training. Musical integration may contribute another piece of the puzzle that is aiding those with math anxiety.

As the arts consistently face budget cuts, both popular and scholarly articles have been written regarding the many ways music benefits overall academic achievement (Gupta, 2009; Kelstrom, 1998). The focus of my research, however, is on the active integration of music in mathematics program delivery. Several resources exist that detail musical mathematics activities for students from preschool to high school (Geist & Geist, 2008; Church, 2006; Fernandez, 1999). Some researchers (Bamberger & diSessa, 2003; Johnson & Edelson, 2003) elaborate on the functional connection between the music in mathematics activities. Geist and Geist (2009)
further describe students’ and teachers’ positive attitudes toward math when music is integrated into math program delivery, although these findings were a by-product rather than focus of their study.

My research is highly influenced by Geist and Geist (2009), however it goes deeper by focussing on teachers who consciously integrate music into their math programs. In addition to examining teachers’ experiences and the resources, I explore what the integration of music into math program delivery feels like for all involved. Little research exists on the benefits of a music-infused math program from the perspective of educators, and therefore this study will build on the work of Geist and Geist (2009) in this area.

1.3 Research Questions

This research study addresses the question: Can the integration of music into teachers’ math programs help to address math anxiety for learners and teachers? Further sub-questions are as follows: How and why are teachers integrating music in their math program delivery? What does music in the math classroom look like and feel like for learners and teachers? Do teachers believe integrating music and math helps learners who suffer from math anxiety and what evidence do they have for these beliefs?

To examine these research questions, a case study approach as detailed by Lincoln and Guba (1985) was taken. Lincoln and Guba (1985) argue that case studies are ideal for naturalistic inquiry, as they afford a detailed examination of a chosen topic, along with the ability for interaction between researcher and participants and an understanding of context. A case study afforded an inquiry into the many facets of music-integrated math program delivery, specifically the functionality of music-infused math instruction and teachers’ motivations, and student and teacher attitudes.
To gather data, I conducted semi-structured, face-to-face interviews with two teachers in the Greater Toronto Area. A postmodern approach to interviewing as outlined by Fontana (2003) was taken. This approach recognizes the importance of a narrative co-constructed by both interviewer and participant. As I learned from my participants, gathering their knowledge and insights for the purpose of improving instructions for learners and educators, I ensured they were given the opportunity to review my findings and provide further input, with the ability to withdraw at any time.

1.4 Background of the Researcher

I have loved mathematics and music since I was a child. I was always told that I would do well in math because I took music lessons, but I never experienced a musical math activity. In examining directions for this research paper, I was curious to see if such activities did exist. I became fascinated while furthering my understanding of the connections between music and mathematics, learning about music-infused mathematics lessons, and reading the rationale behind them.

While math was always a subject that made sense to me, I know the same cannot be said for many people, including my peers in teacher education programs. Students who experience math anxiety may indeed become teachers who experience math anxiety. I wanted to examine how we can produce a math program that helps not only students, but the teachers those students become.

As such, I operated from a pragmatic framework. I explored music’s relationship to math and math anxiety, alongside what can functionally be done through music to address math anxiety. I also worked within a feminist framework. Although not an overt focus of my research, female students experience more negative attitudes toward math than their male peers, and I was
conscious of any way the gender gap could be bridged, including through the integration of music and math.

Music is an art, math a science. For a student who has given up on mathematics, the use of the arts to teach math may be able to change their mind; music may offer an avenue into mathematics for any learner who has yet to find one.

1.5 Overview of Whole

Chapter 1 includes the introduction and purpose of the study, the research questions, as well as how I came to be involved in this topic of study. Chapter 2 contains a review of the literature on this topic. Chapter 3 provides the methodology and procedure used in this study including information about the participants, data collection instruments, and limitations of the study. Chapter 4 identifies the research findings organized around major themes. Chapter 5 includes what was learned, insights, recommendations for practice, and suggestions for further study, and concluding comments. References and a list of appendices follow at the end.
Chapter 2: Literature Review

2.0 Introduction to the Chapter

This literature review begins with a discussion of the causes for math anxiety and effective practices for combatting it, including teaching math conceptually. I propose that incorporating music-infused conceptual math lessons into a teacher’s mathematics teaching could aid in combatting math anxiety. My desire to study the potential for musically-infused math lessons is twofold: first, because music and math share similarities of structure, music may be an interesting avenue for teaching math conceptually, especially to aid students suffering from math anxiety; second, I believe in the value of an arts education, and as the arts constantly face budget cuts (CBC News, 2013; Kelstrom, 1998), it is increasingly important to infuse them into other curriculum areas. The many connections between mathematics and music are discussed, followed by the ways these connections can be used to teach math in the classroom. Finally, I will outline some general benefits to music and arts education.

2.1 Definition of Math Anxiety

Tobias and Wiessbrod (1980) define math anxiety as more than just an avoidance of mathematics; it is “the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve mathematical problems” (p. 65). Tobias (1993) connects failure at math to a feeling of “sudden death” (p. 50). Chernoff and Stone (2014) characterise math anxiety as an illness that can be transmitted, but also controlled and alleviated. Symptoms of math anxiety include fear of failure, a distrust of intuition, and self-defeating self-talk (Tobias, 1993), and may manifest physically as an increase in heart rate, sweating, nausea, headaches, and panic (Chernoff & Stone, 2014). In order to address these symptoms, however, we must first understand the causes.
2.1.1 Causes of and Strategies for Reducing Math Anxiety

Tobias (1993) points to some characteristics of mathematics that make its study susceptible to anxiety. Tobias (1993) notes that math is complex, math becomes more abstract the further you study it, math has its own meaning for certain vocabulary, and its everyday application is not as readily apparent to students. The anxiety students experience, however, does not come from the mathematics itself (Stuart, 2000), but the classroom teacher’s attitude towards math, and the way mathematics is taught.

If math anxiety is to be understood as a disease that can be passed on (Chernoff & Stone, 2014), it is important to note how this may play out in the classroom. Math teachers play a critical role in the way their students feel about math, both through the teachers’ own beliefs about their ability and comfort level teaching math, and through the way math is taught (Chernoff & Stone, 2014). Teachers with math anxiety are more likely to assign individual seat work over collaborative mathematics activities (Aslan, 2013; Furner & Berman, 2003), and may cause students to develop math anxiety of their own (Furner & Berman, 2003; Hembree, 1990). Teachers who suffer from math anxiety must address it, as well as become familiar with best practices for teaching math (Furner & Berman, 2003). The use of these practices will in turn help reduce math anxiety in students.

Reducing mathematics anxiety in students ultimately means changing the way math is taught (Geist, 2010). The National Council of Teachers of Mathematics (1995) lists best practices for teachers seeking to prevent math anxiety in their students: accommodating for different learning styles, using a variety of evaluation methods, creating a positive math class experience, not connecting students’ self-esteem to success in math, emphasising that everyone makes mistakes, making math relevant, and emphasising the importance of original problem
solving over rote memorization. Finlayson (2014) notes the importance of the constructivist teaching approach, which involves actively engaging students and developing activities that are student-centred.

Teaching math conceptually is also very important to mediating the effects of math anxiety. Conceptual math emphasizes student understanding of mathematics over memorization of algorithms and formulas (Cavanagh, 2006). Furner and Berman (2003) argue for the importance of focusing on the process of problem solving over the end result, increasing communication in the classroom through discussion and student writing, and sharing thinking processes.

John Mighton, founder of Junior Undiscovered Math Prodigies (JUMP) Math, advocates a slightly different approach. Although he does not deny that understanding math conceptually is important, he emphasizes the need for students to possess basic numeracy and logic skills (developed in part through rote practice), along with the confidence and motivation to understand math. In the JUMP Math curriculum, problems are broken down into simple, easily understandable steps. These steps not only help students with math anxiety, but they help educators as well. The results Mighton has observed as a consequence of his system have been highly promising, with his first student going on to pursue math in high school past when it was mandatory. Through the JUMP Math program, this student developed a love of a subject she had initially detested (Mighton, 2003).

JUMP Math was first developed as a method to help students who already struggle in math. As such, there is an emphasis on confidence building and learning through basic steps over learning conceptually at first. Because of the functionality of this program, I believe Mighton takes the correct approach. Someone who already has a dislike for math will find no enjoyment
in discovering mathematical concepts; it is more important to build their confidence through simple steps at first. Once they feel they are a mathematician, then it is important to include more experiments and open-ended activities. These conceptual activities may include music-infused math activities that build on the many structural connections between math and music.

2.2 The Connections Between Math and Music

In its simplest form, musicality can be seen in almost anything: the gentle rhythm of waves on the shore, the constant ticking of a vehicle’s turn signal, the blaring alarm clock to wake us up in the morning (Garland & Kahn, 1995). These musical phenomena are also mathematical repeating patterns. Historically, many thinkers have linked music and mathematics, Johannes Kepler even used music to explain the universe (Field, 2003). Both disciplines also make use of an internationally understood system of notation to convey complex thought and ideas (Wollenberg, 2003), and mathematics can help explain numerous musical phenomena.

One such connection between mathematics and music is the explanation of the qualities of a musical sound. Sound is created by changes in air pressure, visually represented as sound waves. The sound waves of non-musical sounds (“noise”) create no repeated pattern, while musical sounds do. That, in part, is what gives musical sounds their unique tone (Harkleroad, 2006). The mathematical pattern of the sound wave gives the sound its musical quality.

Figure 1. The sound waves created by the non-musical sound of static on a television set (Harkleroad, 2006, p. 5).
Figure 2. The sound waves created by the musical sound of a clarinet (Harkleroad, 2006, p. 6).

While the repeating pattern of sound waves gives a sound its musical quality, the number of times this pattern repeats per minute (the pattern’s frequency) determines the pitch of this musical sound. The relationship between different pitches can also be explained mathematically. A discovery associated with Pythagoras is that cutting the length of a plucked string in half raises the note of that string by the interval of an octave (from the bottom to the top of a scale).

Figure 3. Diagram of a string of length $l$ and a string of length $l/2$. The shorter string will sound a note exactly one octave higher than the longer string when plucked (Garland & Kahn, 1995, p. 47).

Almost 2000 years later, the French mathematician Marin Mersenne made the connection between pitch and frequency. Mersenne determined that raising a note by an octave doubles that note’s frequency (Harkleroad, 2006).
Figure 4. The keys of a piano labelled with their note name. The two Cs in the diagram are an octave apart, thus the higher C has a frequency of two times the lower C. Additional ratio relationships between the frequencies of the notes are also shown (Harkleroad, 2006, p. 25).

Mathematics also plays an important role in rhythm. In music, rhythm measures time and occurs when the sound is broken into pieces through a change in sound or movement. Western music theory has developed rules to conceptualize rhythm, and they will be discussed in order to make clear the connection between mathematics and music that arises from rhythm. Pieces of music are divided into measures (or bars), which measure equal amounts of time (or the same number of beats). The time signature appears at the beginning of a piece of music. It tells how many beats there will be in each bar, and what kind of note will determine the value of one beat. A common time signature is “four four time,” meaning there are four beats in a bar, with the quarter note having one beat.

Figure 5. Diagram showing measures (or bars) divided by bar lines and a time signature of “four four time” (Garland & Kahn, 1995, p. 7).

In this time signature, when an entire measure is taken up by one note (which would last four beats), that note is called a whole note. If the measure is taken up by two notes of equal value (each lasting two beats each for a total of four beats in the measure), the notes are called
half notes. If the measure is divided into four notes of equal value (each lasting one beat), the notes are called quarter notes.

![Musical notation showing a whole note, a half note, and a quarter note.](image)

*Figure 6.* In “four four time,” one whole note, two half notes, or four quarter notes last the duration of one bar (Garland & Kahn, 1995, p. 8).

In using the correct number and value of notes to form complete measures, composers and musicians make use of knowledge about fractions, ratio, and proportion.

### 2.3 Integrating Music into the Mathematics Classroom

Given these connections, mathematics lends itself quite well to being taught through music. Indeed, many resources exist to instruct educators on how to use one to teach the other. Mendelsohn (1990) argues that mathematical songs can be used to improve children’s moods and enjoyment of a math lesson. Mendelsohn reasons that since children generally love music, teachers should use that to their advantage. Mendelsohn includes sheet music for several songs that can be used to review concepts of arithmetic, geometry, measurement, telling time, and money. For the most part, these activities use song to reinforce mathematical concepts, and do not draw on the connection of the inherent mathematical structure of music. One clever song, however, uses the musical structure to echo what is being sung. In “How Many Ways,” Mendelsohn reviews addition facts for numbers up to 10, and as each number is sung, the musical patterns reinforce the addition patterns. This type of musical math activity is the most
beneficial: an activity that makes use of the properties of music to enhance mathematical understanding.

In fact, many authors do describe activities that make use of pattern, pitch, and rhythm to reinforce mathematical concepts (Geist, Geist, & Kuznik, 2012; Geist & Geist, 2008; Church, 2006; Johnson & Edelson, 2003; Fernandez, 1999). These authors detail activities teachers can use in the classroom, sometimes including the theoretical underpinning. The communication of the activities themselves is most important for teacher use, but it adds to the educator’s understanding if they comprehend the method that informs each activity. Johnson and Edelson (2003) detail several lesson ideas that make use of music’s structure to teach math to children in primary grades. In one activity, kindergarteners practice ordering by identifying whether the notes they hear go from low to high or high to low. Older students can practice fractions by creating measures of four beats using notes of different values then clapping them together. After first investigating how to create a measure using only whole notes, half notes, quarter notes, and eighth notes, students then create their own. In this way, they reinforce understanding of equivalent fractions and ratios. These articles discuss exciting possibilities for the integration of math and music, but miss the perspective of the teacher. The present study further examines the educator’s perspective on the usefulness of using music to teach math and how their students respond.

Not only do Geist and Geist (2009) discuss some ways teachers could integrate music into a kindergarten mathematics classroom, they also talk about how music integration can benefit teachers. After initially finding that the kindergarten teacher participants in their study were hesitant to teach math and found it stressful, Geist and Geist determined that teachers actually were much more comfortable than they thought teaching math, often reinforcing
mathematical concepts without realising it, including through the use of music. Like Mendelsohn (1990), Geist and Geist (2009) note that musical math activities are enjoyable to students and even observed students engaging in some activities outside of classroom time. Just as the process of JUMP Math helps build confidence in educators who struggle with math anxiety, Geist and Geist (2009) found that the use of music makes math fun for teachers and students.

One case study that was able to do just that was a collaboration between Bolton Elementary School in Winston-Salem, North Carolina and the local symphony orchestra that used music to teach a vast number of subjects, including math. Through a yearlong program, musicians from the orchestra taught literacy, language arts, opposites, and mathematics using a music-infused curriculum. The project built on Gardner’s Theory of Multiple Intelligences, finding ways to authentically use different aspects of music to teach an appropriate corresponding subject. Making music involves reading music (Gardner’s Linguistic Intelligence), rhythm (Logical-mathematical Intelligence), playing an instrument (Bodily-kinaesthetic Intelligence), ensemble playing (Spatial and Interpersonal Intelligence), and of course Musical Intelligence, which brings these other areas together (Perret & Fox, 2004). The National Council for Teachers of Mathematics notes the importance of accommodating different learning styles in preventing math anxiety (1995), and bringing music into the math classroom may be beneficial for more than just musical learners.

The results of the Bolton Elementary School program are promising. The music-infused curriculum not only helped the students at Bolton Elementary School with their self-confidence and self-esteem, but increased student attendance and parental involvement in the school as well, with results demonstrated at other schools in the United States as well (Perret & Fox, 2004).
music-integrated curriculum with this scope and facilitated by professional musicians would be ideal for students. Not all schools have this opportunity, however.

Many resources exist to show teachers how they may use music during math time. The present study examines the accessibility of these resources, and the potential benefits of adding music into the mathematics classroom for students and teachers.

2.4 The Benefits of Studying Music

There are numerous benefits to the study of music (Gupta, 2009; Kelstrom, 1998). Studying an instrument builds visual and spatial skills (Gupta, 2009). Kelstrom (1998) argues that music education is just as important as education in language arts, mathematics, and science, and students who study music generally have higher Grade Point Averages compared to students who do not study music. However, in a meta-analysis of causational studies that examine the educational benefits of studying music, Črnčec, Wilson, and Prior (2006) found some evidence for the study of music’s ability to enhance spatial ability, but inconclusive evidence for music’s benefit in the areas of mathematics, reading, and Intelligence Quotient. This is not to say that Črnčec et al. (2006) do not support the study of music. Rather, they argue that music should be studied in schools based on its own merit as a vehicle for emotional expression and communication. Indeed, some educators in the United States are beginning to focus on music’s benefit to children’s creativity and teamwork, not something to be sidelined for a sole focus on student test scores in mathematics and reading (McCammon, 2014). I know firsthand how important music education is. Through my own study of music, I learned an appreciation for the arts, practiced teamwork, and was afforded a creative outlet. As the arts continue to face cuts in public schools (CBC News, 2013), it is important to bring them into other subjects, but more importantly, the study of music is valuable for what it can add to a student’s development.
2.5 Conclusion

Music is an inherently human experience. Caregivers sing to young children, musical concerts of all types draw eager crowds, and everyone loves to sing in the shower. Music brings us together across cultures and through time. Mathematics, however, may produce feelings of anxiety in students, and even those who have long since finished grade school and become teachers themselves. There has been some promising evidence that teaching math conceptually is one piece in the puzzle to aiding those who suffer from math anxiety. Many resources exist detailing music-infused math activities teachers could use in the classroom. The present study investigates the experience of teachers who consistently make use of similar resources in the Greater Toronto Area public school context and their perspectives on the possibilities of a music-infused math program.
Chapter 3: Research Methodology

3.0 Introduction

This chapter describes the research methodology used to examine the question, “Can the integration of music into teachers’ math programs help to address math anxiety for learners and teachers?” The research approach and procedures, data collection instruments, and participant information is outlined. Data analysis is then discussed before reviewing ethical considerations relevant to the present study. Finally, the methodological limitations and strengths of the research study are conveyed along with the rationale for this methodology given the area of study and purpose.

3.1 Research Approach & Procedures

This research study was conducted using a qualitative research approach involving a literature review and semi-structured interviews with teachers. Qualitative research involves “ways of understanding ourselves as persons” (Kvale & Brinkmann, 2009, p. 12) within an “interpretive, naturalistic approach to the world” (Denzin & Lincoln, 2011, p. 3). Qualitative research aims to collect data in a naturalistic setting and includes the voices of participants (Creswell, 2013).

Within the qualitative research framework, I take a case study approach as detailed by Lincoln and Guba (1985). Lincoln and Guba (1985) argue that case studies are ideal for naturalistic inquiry, as they afford a detailed examination of a chosen topic, along with the ability for interaction between researcher and participants and an understanding of context. I aimed to determine the functionality of music-infused math instruction, along with teacher motivations, and student and teacher experience. A case study afforded an inquiry into the many facets of music-integrated math program delivery.
3.2 Instruments of Data Collection

To gather data, I conducted semi-structured, face-to-face interviews with two teachers in the Greater Toronto Area. Interviewing provided a naturalistic means to gain information, while allowing for deeper understanding into a participant’s own lived experience and perspective (Kvale & Brinkmann, 2009). My research goal was to understand what a music-infused math curriculum looks and feels like for teachers and students, and an interview provided them the opportunity to tell me in their own words. A semi-structured interview allowed for consistency between interviews, while providing the opportunity to further explore topics as they arose in a given interview (O’Leary, 2010), and being face-to-face allowed for me to read informal cues such as the participants’ facial expressions and body language (Creswell, 2013).

I took a postmodern approach to interviewing as outlined by Fontana (2003). This approach recognizes the importance of a narrative co-constructed by both interviewer and participant. As I learned from my participants, gathering their knowledge and insights for the purpose of improving instructions for learners and educators, I ensured they were given the opportunity to review my findings and provide further input, with the ability to withdraw at any time.

3.3 Participants

In this section, criteria for finding participants are outlined, along with avenues for participant recruitment and further information about my participants.

3.3.1 Sampling Criteria

To participate in this research study, individuals needed to meet the following criteria:

- Five or more years’ experience teaching math to students in the Greater Toronto Area
- Five or more years’ experience using music in their math program delivery
• Experience using music to teach math to students with mathematics anxiety

As I aimed to understand the effects of using music as a tool to teach math, my interview participants had experience teaching math. I also wanted to understand the particulars of using music to teach math in the Greater Toronto Area, as it is where I am learning to become a teacher myself. Not only did participants need experience teaching math, but they needed experience using music to do it. Five years gives teachers enough time to observe the effects of their teaching practices on themselves and their students. Finally, my participants needed to have experience working with students with math anxiety. My research aimed to better understand the effects of music integration on students with math anxiety, thus my participants needed to have experience working with these students and observing the effects of a musical math program.

3.3.2 Sampling procedures

To recruit participants, I employed convenience sampling, searching for teachers who had experience in various divisions. I also aimed to find teachers who had experienced math anxiety themselves. By finding participants who have worked with students of different ages, as well as ones who may have been uncomfortable teaching math themselves, the study is more likely to represent different perspectives (Creswell, 2013).

To find participants I contacted individuals who knew teachers meeting my sampling criteria. I also provided my information rather than ask for the information of potential participants in order to ensure individuals were volunteering to participate rather than feeling pressure or obligation.

3.3.3 Participant Biographies

Both participants of the present study are professionals in the field of education in the Greater Toronto Area, Canada. They are both classroom teachers at publicly funded Ontario
schools, each with at least five years experience in the classroom, and working with students with math anxiety. The participants will remain anonymous through pseudonyms.

Joan

Joan is currently a Full-Day Kindergarten teacher in her twenty-sixth year of teaching. She has experience teaching students from kindergarten to Grade 3, and has experience as a Primary Math Coach. She reached a Grade 2 Royal Conservatory of Music level on piano and has taken vocal lessons, but her interest in music stems from an inherent love of it, rather than formal training. Joan also experienced math anxiety.

Morgan

Morgan currently teaches Grade 9 and Grade 10 Applied Math, Grade 12 University Math, and French. She also has experience teaching Grade 11, Mixed College and University Level, and Essential Level math. She took piano and guitar lessons growing up, and has experience teaching piano. She has also experienced math anxiety.

3.4 Data Analysis

After completing the interviews, they were transcribed and read numerous times.

Pietkiewicz & Smith (2014) outline the following steps for qualitative analysis:

Step 1: Multiple reading and making notes

Step 2: Transforming notes into emergent themes

Step 3: Seeking relationships and clustering themes

Pietkiewicz & Smith (2014) describe the importance of multiple readings of transcripts and listenings to audio recordings as they help “researchers immerse themselves in the data” (p. 12). Agar (1980) points to the importance of reading and re-reading as they pertain to an
“understanding of the interview as a whole before breaking it into parts” (p. 103). This gave me a good understanding of my interview as a whole before I moved on to more abstract data analysis.

Rather than creating themes directly from the transcript as Pietkiewicz & Smith (2014) suggest, I first created codes from the transcript, then categorized these codes into categories, which were then organized into themes (Saldana, 2008). Rossman & Rallis (2003) describe a code as short, explicit description of the data while a theme “is a phrase or sentence describing more subtle and tacit processes” (p. 282).

I mainly used Descriptive Codes as I found they helped me tease out the essence of a segment of data while still holding meaning. In some cases, the participant’s wording or tone were highly meaningful to me (for example, “we talk about it”), so in those cases I used In Vivo Codes. Finally, Values Codes helped me capture my interpreted participant perspective on my research topic of music and math integration (Saldana, 2008).

I then grouped similar codes into related categories, re-examining and re-evaluating the categories as I went. The categorization process allowed for some analysis of the codes taken directly from the research (Saldana, 2008). Once my interviews were complete and coded and categorized individually, I sought relationships and clustered themes among both interviews (Pietkiewicz & Smith, 2014). Finally, I made meaning from these themes and situated them within existing research on this topic (Creswell, 2013).

3.5 Ethical Review Procedures

When conducting this qualitative research study, I ensured I considered pertinent ethical issues as outlined by Creswell (2013). Although there were no known risks to participating in this study, the nature of interviewing creates a power imbalance between the interviewer and participants (Kvale & Brinkmann, 2009). In order to protect participants, they were given a letter
of consent to be interviewed and audio-recorded (Appendix A). This letter includes information about the purpose of the study, ethical implications, and specifics of the study. Participants were told they did not have to sign the form, and if they did sign they could withdraw their consent at any time. Both participants were assigned a pseudonym and their identities and any identifying markers will remain confidential. All data, meaning audio recordings and transcripts, will be stored on a password-protected computer and destroyed after five years. Participants were also able to review interview transcripts to ensure they felt their answers were accurately represented. During data analysis, I ensured I did not side with participants and only disclose positive results, and on completion of the study, I ensured I used accessible language and disseminated my research in multiple formats, including online (Creswell, 2013).

3.6 Methodological Limitations and Strengths

Due to the increased ethical concerns of working with vulnerable populations like children (Creswell, 2013), students were not observed or interviewed for this case study. The student experience itself would provide valuable insight into the use of music as a teaching strategy for mathematics, so I asked teacher-participants questions on their perceived student experience. As I conducted interviews with only two educators, that limits the generalizability of the research. I will only be able to inform the understanding of using music as a math-teaching tool. Denzin and Lincoln (2011) note that more than one interpretive practice is needed when conducting qualitative research, as each practice “makes the world visible in a different way” (p. 4). While this study only makes use of interviews, my participants came from different teaching experiences and perspectives, thus giving a deeper understanding of the topic (Creswell, 2013).

The practice of interviewing teachers provided in-depth reflection on the use of music to teach math from teachers’ perspectives (Kvale & Brinkmann, 2009). By interviewing teachers
who have used music as a math teaching tool for five years or more, I was able to investigate their insights on this practice gathered over time. Because teachers work daily with students, they provide their take on how the practice affects students. While interviewing does have its methodological limitations, it allows for teachers to share their perspective on their experiences.

3.7 Conclusion

In this chapter I have discussed the methodology for this research study as well as the rationale behind that methodology. I took a qualitative case study approach to my research as it afforded a naturalistic means to understand teachers’ lived experiences and insights. Semi-structured, face-to-face interviews allowed me to gain deeper understanding of a music-infused math program by giving participants the chance to discuss their understanding of the topic. I used convenience sampling with the aim of finding teachers from different backgrounds in order to afford an understanding of the research topic from different perspectives. Data was analysed in order to find themes and interpreted in order to determine what can be taken away from this research. Ethical considerations were made throughout the process. Although there are limitations to the study, it also affords an important insight into teachers’ experiences using music to teach math, and the effect on students with math anxiety. Next in Chapter 4 I review my results.
Chapter 4: Research Findings

4.0 Introduction to the Chapter

This chapter presents and discusses the findings that emerged through the data analysis of the research interviews. Throughout the analysis, I was constantly mindful of my research question: Can the integration of music into teachers’ math programs help to address math anxiety for learners and teachers? while examining teacher practices and the experience of musical math activities for learners and teachers. In the discussion, connections are drawn between participants’ experiences and perceptions and the Chapter 2 literature review. Findings are organized into four main themes:

1. Factors influencing the use of music in the math classroom,
2. Use of music in the math classroom,
3. Music’s perceived effect on students in the math classroom, and
4. Supporting learners with math anxiety.

These themes also have sub-themes that further illustrate how they play out in a classroom. For each theme, I will first describe it, then report on the data, and finally discuss the significance of each theme within the context of the existing literature. Finally, I summarize my findings and make recommendations for next steps.

4.1 Factors influencing the use of music in the math classroom

I found the most significant factor influencing my participants’ use of music in their math classrooms was their background experiences and comfort with music, further supported by participants’ use of music in other subject areas as well as the perception that other teachers do not use music when they teach math. I will first discuss the way the backgrounds of Jane and Morgan influence how they use music in the math classroom. Then, I will touch briefly on the
participants’ use of music in other subjects. Finally, I will talk about the teachers’ perceptions of other teachers not using music in their math classrooms and their hypothesized reasons why such integration does not take place.

### 4.1.1 Participants’ musical comfort and backgrounds

The main reason participants use music in their math class is because of their background and high comfort level with music. While participants noted connections between math and music, their main decision to use it was their own background and experiences with music.

When asked why she integrates music into her math program, Joan responded, “It wasn’t even a conscious decision, it was my left arm, I just did it. It’s more natural to me sometimes than even talking.” While Joan had little formal music training, she said music was “just always in [her]” and that it was natural for her to bring rhymes and songs into her classroom. Interviewing Joan, there was a sense of authenticity when it came to bringing music into her teaching. She noted, “I feel like I’m just so authentic and in my zone when I’m doing it, I really do.” Morgan had more formal training in music, having played piano and guitar, and having taught piano as well. She also notes that her own high school math teacher would play classical music during his class, and that was something that helped her focus. For Morgan, “if [she] has music [she] can focus on [her] work.”

The majority of writing on the use of music in the math classroom surrounds its justification and strategies. It does not, however, discuss additional reasons why teachers may or may not use music in their math classrooms. Church (2006) and Geist and Geist (2008), for example, give a brief introduction to the elements of music in their articles, outline their musical math activities in clear, accessible language, and provide evidence for the benefits of using music to teach math. Despite this apparent appeal to teachers without music backgrounds, the
participants use music because of their own backgrounds and love of the discipline. While this is beneficial for the students of these teachers, it raises the question of what can be done to encourage those teachers who do not use music in their math classrooms to start.

### 4.1.2 Participants’ use of music in other subject areas

It was clear that these participants value music, not just for its connections to math, but as a discipline on its own, as supported by their use of music in subject areas other than math. Because of their background and comfort with music, these teachers used it to teach their other subjects as well.

Joan was highly integrative in all her lessons. She gave an example of one activity that uses a modified version of the song Willoughby Wallaby by Raffi to bring song into language arts: “[A]t the very beginning of the year we did Willoughby Wallaby with a baby elephant. [Singing] ‘Willoughby Wallaby wee, an elephant sat on me, Willoughby Wallaby Wathryn, the elephant sat on Kathryn.’” Joan will then build on this activity, taking two names and switching the starting sounds. Joan said, “[The students] just have a fabulous time, but they don’t realize they’re having [letters and sounds] consolidated for them … and if you rearrange them you’ll end up with a different product.” Joan is also currently creating songs as part of a children’s yoga program to help the participants remember the various poses.

Morgan also teaches high school French, and described an activity she uses to bring music into the French classroom. After finding a French song popular in Quebec or France, she will print out the lyrics and bring them to class, and use them as a basis for discussion. After she ensures the students understand the songs on a surface level, the students will discuss their thoughts and what the song is actually about. Morgan notes the exercise is “pretty cool to […]"
get conversation and discussion going in the French class.” Both teachers value music, so they use it in subjects outside of math as well.

This teacher practice relates to the broader benefits of integrating music into other subject areas. In the Bolton Elementary School case study (Perret & Fox, 2004) where local orchestral musicians taught several subjects (including mathematics) through a musical lens, student self-confidence, self-esteem, attendance, and parent involvement all increased. This program may provide insight into the problem of teachers feeling uncomfortable bringing music into the classroom themselves: they could bring in musicians instead. That raises questions of feasibility, however, and whose responsibility it would be to create lessons.

This practice also ties into the many benefits of studying music (outlined by Gupta, 2009; Črnčec, Wilson, & Prior, 2006; Perret & Fox, 2004; Kelstrom, 1998). The more students are exposed to music, the better for their emotional expression and communication. Bringing music into other classrooms allows students who are musical thinkers to connect to the material and be able to express themselves more comfortably. As the arts are also facing cuts in public schools (CBC, 2013), it is important to expose students to them through as many avenues as possible.

While the focus of the current study is on the use of music to teach math, learning that the participants incorporate music into their other subject areas is further support for the benefits of music and music education.

4.1.3 Perceived lack of musical integration into math by other teachers

When asked about the feedback they receive for their use of music in the math classroom, Joan and Morgan noted it was very positive. They also noted, however, that they do not know many other people who do what they do. Joan mentioned a friend of hers who integrates the arts into her program, but again, this teacher is “so creatively driven” that her love of the arts is what
motivates her to use them in her program. Morgan hypothesized that the lack of music integration by other teachers came down to other teachers “us[ing] other strategies that [Morgan doesn’t]. [It’s] just a teaching style difference.”

This relates to a larger issue of how to help teachers feel comfortable integrating music into their math classroom. As previously discussed, while some authors may write articles that invite teachers without a music background to use music in their math program, it seems as though teachers still need to be comfortable with music to consider using it in their classrooms.

### 4.2 How music is used in the math classroom

This theme centres on what participants of the study are actually doing when it comes to bringing music into their math programs. Both participants make use of songs to convey mathematical concepts, while the inherent mathematical nature of music comes into play as a support for math but not as a separate tool used to study it.

#### 4.2.1 Use of song to convey mathematical concepts

When asked how they use music in their math programs, both participants spoke to the use of songs to teach and reinforce concepts. Teachers would take a concept they were covering and either create or find a song that reviews those concepts. Where the teachers differ, however, is where the songs come from. Morgan draws heavily from the website TeacherTube, an online repository of videos teachers can use in their classrooms. Joan creates the songs she uses herself.

In one activity Joan uses with her kindergarten students, rhyme and music are used to review numbers and how numbers can be built different ways. In the activity:

Students put their hands behind their back and we sing, [singing] ‘Clickety clack, clickety clack, put your hands behind your back.’ I’ll say, [singing] ‘Open the window, open the door, the number I’ve got is the number …’ And before I show them four, they all realise
'Oh [...] door rhymes with four!' So they all shout four and I’ll say, ‘How did you build four?’ And someone will build it with one hand, some will build it with two, and that gives them the experience that you can deconstruct numbers in different ways. Then I’ll show them how I did mine.

In another activity, Joan uses music to teach counting, with rhyme indicating the number that comes next. The rhyme is as follows: “One raindrop, dripping on my shoe, along came another and then there were two. Two raindrops, skipping up my knee, along came another and then there were three,” with the rhyme eventually going all the way up to 10. To reinforce concepts of measurement, Joan and her class will say, “Heal toe, heal toe, measure measure as I go. Don’t overlap or make a space, but make them touch each time. Heal toe, heal toe, I measure on a line.”

Morgan finds similar songs on TeacherTube, but covering different concepts. She describes a sample song and students’ initial reactions:

So … for example, [they take the song] Teach me How to Dougie, but instead they’re singing, ‘Teach me how to factor.’ So it’s so funny and the kids are like, ‘Aww Miss it’s so dumb!’ But then for […] two weeks afterwards they’re singing, ‘Teach me how to factor, teach me, teach me how to factor …’ They love it.

While there is clearly more initial buy-in from the kindergarten students on the use of songs in math class, Morgan’s older students do eventually come to use the songs as tools to help them review mathematical concepts.

In her justification for the use of music in the math classroom, Mendelsohn (1990) argues that songs can help improve children’s moods and enjoyment of the lesson, thus making them more receptive to learning. Like the examples given by Joan and Morgan, Mendelsohn provides
songs that can be used to review mathematical concepts that, for the most part, do not draw on the inherent connections between math and music. Such an activity could be used in any subject. While I think this type of music integration is better than no integration, I feel activities that make use of the music-math connection offer a richer experience for students, and several of these activities are outlined by other authors (Geist, Geist, & Kuznik, 2012; Geist & Geist, 2008; Church, 2006; Johnson & Edelson, 2003; Fernandez, 1999). Where these songs could have an added benefit, it is in the subtle way they reinforce mathematical concepts.

**4.2.2 Musical elements support mathematical concepts**

While the structure of music may not have been consistently used to teach mathematical concepts, both participants spoke to the mathematical elements present in music that students are exposed to through the math songs. The use of music to support concepts of patterning came through in both interviews. Morgan notes the “beat and regularity” in music helped her when she was studying math, as “math also has a beat, has a regularity, and […] patterns.” While musical structures are not being drawn on to teach math, their connections still support student development.

Morgan also made an interesting point about the automaticity that comes with proficiency in math and music that I have not read before. She notes that in music, there are “different [intervals, for example], major fifth, an octave, whatever it is, that you’re actually using the numbers and you do it unconsciously,” which is ultimately where a student should be when they use numbers in math as well.

Several authors outline the myriad connections between music and math (Harkleroad, 2006; Field, 2003; Garland & Kahn, 1995). Whether it is enough to simply include music without making use of deeper connections is uncertain in the literature, as many activities
detailed by authors speak to those deeper connections. For those teachers who are using music, how can we ensure they also bring in richer tasks to help student understanding?

4.2.3 Lack of activities that draw on the deep music-math connection

While the majority of activities discussed were mathematical songs, Joan did outline the way she brought changes in volume (dynamics) into a math song to convey the concept of growing and shrinking patterns. Elaborating on her Raindrop counting activity, when the students counted up they:

Built this thunderstorm, then [say], ‘Drip drop, drip drop, 10, nine, eight, seven, six, five, four, three, two, one, the rain did stop.’ So we made the crescendo of a storm and then brought it down, but then we deconstructed that and talked about how it was a growing pattern, and how the rain started to go away and drift, it was a shrinking pattern. So that was really dramatization, language, math, and music all at once.

This explicit discussion of the math present in the musical structure was not always present. Throughout the literature there were many lesson plans that outline activities for teachers to use the inherent structure of music in their math lessons (Geist, Geist, & Kuznik, 2012; Geist & Geist, 2008; Church, 2006; Johnson & Edelson, 2003; Fernandez, 1999). Many rich tasks, such as those that review fractions or sound, were for junior students, however. Because the participants teach kindergarten and high school, perhaps they did not have the topics to cover to regularly create these rich tasks. Another reason could be the teachers’ approaches. Joan is so integrated in everything she does that she draws on several subjects for each activity because that is the way she teaches. In any given activity, the mathematical structure of music may be a supplement to a larger learning goal and not the focus. The resources to deliver these kinds of lessons may also be harder for teachers to access. Many were available through
academic journals as opposed to websites, and may require more planning. More needs to be done to ensure students experience rich musical math tasks.

4.3 Music’s perceived effect on students in the math classroom

While participants are motivated to use music in their classrooms because of their own experiences, their perceived impact on students was also positive. This positivity centred around the environment created by the use of music.

When Joan reflects on the effect her music has on students, she says simply, “pure joy.” She expanded further:

[I]t just brought this joy in, this happiness, and it bonded us more as a community, it did. And, they realized their untapped musical strengths sometimes. It didn’t mean that they didn’t struggle, and certainly had misconceptions and everything, but I just think it kind of, it took an edge off.

Feeling like they belonged in a welcoming community helped open students up to math lessons. Joan also found that singing to children has the effect of grabbing their attention in the way speaking does not.

Morgan uses music as a means to aid student self-regulation. She keeps music on constantly in her classroom, even when she is teaching. In her own words Morgan says:

I feel like it keeps my classes sort of under control. […] Because when I’m teaching and I want them to be listening, it helps to remind them that if there’s music playing and if I can’t hear the music then they’re being too loud.

Morgan will also use music to control the mood in the classroom. If she needs the students to be more energetic and engaged, she will put on songs with faster tempos, and during a work period Morgan will put on a slower song. While it may seem counter-intuitive for
Morgan to play music during her teaching, the students respond well to it. On the day of the interview she had had a student ask to keep music on during a test, which indicated to Morgan that the student found the music playing helpful.

While much of the musical math literature speaks to activities teachers can use in the classroom, Geist and Geist (2009) and Mendelsohn (1999) discuss the benefits of bringing music into the math classroom as it makes math fun for students and educators, in addition to the benefits of studying music discussed in the literature (Gupta, 2009; Kelstrom, 1998). That finding is reflected in participants’ perceptions of students. How then, can teachers without a music background find ways of bringing music into their math classroom to help create a sense of community?

Morgan’s use of music to help students self-regulate is reflected in the literature review by Črnčec, Wilson, and Prior (2006). When soothing music was played in a classroom for students with diverse learning needs, the music had a calming effect on the students. In the same way, Morgan uses music to help her students stay focused or keep them calm during a work period. This is one strategy any teacher could easily implement, regardless of their music background. The effects of music integration are certainly positive on both students and teachers; it is now a matter of making teachers feel comfortable enough with music to use it.

4.4 Supporting learners with math anxiety

This theme is separate from Music’s effect on learners in the classroom, as teachers used many strategies to support their learners with math anxiety, with music integration being one strategy. This stems from teachers’ own experiences with math anxiety. Both study participants found that a sense of community with their fellow math learners helped them gain comfort in math.
4.4.1 A sense of community helped teachers with their own math anxiety

Both Joan and Morgan have experienced math anxiety, and both found a supportive class community was instrumental in helping them overcome that anxiety. Joan completed the Mathematics Additional Qualification Specialist because the Toronto District School Board subsidized it. She said, “I never ever would have gone for it except I needed to go up the pay scale, and I took Math 1, and had such a strong, tight cohort of people we all agreed, ‘OK let’s stick together.’” Similarly, when Morgan took mathematics in university, she found she struggled with the way the professors explained the concepts. She is a very practical learner, and the teachers were being too theoretical. In this context, she learned, “To do math, it’s not an individual thing.” She found that when she could not understand her professors:

My friends would then […] give me examples, walk me through it and everything, and that gave me a chance to actually try it myself and then understand it. […] So […] I take that in when I go to my class and I let them do examples during the lesson and we do it that way.

Morgan found that various examples and support helped her understand math, so that is what she brings to her classroom. Joan also experienced anxiety with teaching junior math in her role as a math coach for the school board. She had a collection of songs and games that worked in the primary math classroom, but she was unsure how these would work in a junior setting. So instead with the junior students she, “would link it a lot with drama.” One example is using a gas station activity to help students understand rounding numbers to the nearest 10.

Because math anxiety is susceptible to being passed from teacher to student (Chernoff & Stone, 2014), it was important both Joan and Morgan were able to tackle their math anxiety. Furner and Berman (2003) stress the importance of teachers who suffer from math anxiety
addressing it and ensuring they learn best practices for overcoming that anxiety. Both teachers found a supportive community helped them through their math courses, and Morgan found that many different examples was also helpful, while Joan found a way to incorporate drama to teach math in the older grades.

4.4.2 Music is one of many strategies teachers use to support students

Both participants noted the community aspect to mathematics learning, thus they ensure they bring that into their classrooms. They also each have a unique approach based on their background and what helped them overcome their anxiety. For Joan with a kindergarten class, she uses song and integration. For Morgan’s high school students, she uses humour and songs to support students as well, but the overarching idea is community. They also stress allowing students to explain and demonstrate their thinking many different ways.

I have already spoken to Joan’s description of the sense of community that comes to her class when songs and music are used. While that community is important for all learners, it is especially important for learners who struggle. Her other important practice for helping these learners is making sure they:

[Understand] that you can express your understanding in different ways, so the drawing piece is important. Oral language is also so, so, so important in demonstrating understanding, so if they really have anxiety around a paper-pencil task, they could explain it more orally, or dramatize it, or do a picture, as long as that understanding came through in an area that they can communicate most effectively.

Joan’s authenticity in the way she brings music and musical thinking into her classroom allows students to feel safe and comfortable expressing their ideas in different ways as well.
Joan’s continued use of song builds community in her classroom. Morgan’s high school students do not as easily buy in to the use of song, but she does note that using songs that give step-by-step explanations for math operations are helpful for students. In a song about how to find the perimeter of a polygon, the chorus features the word “perimeter” on repeat. When it comes to the chorus, however, it says, “Take all the sides and add them up.” Morgan finds that when students get into a test situation, she is able to prompt her students using the song. She will say to her students, “‘What am I supposed to do here?’ and [she’ll] say […] ‘Remember the song? Take all the sides and …? [and the students will respond with] ‘Add them up,’” completing the song lyric. Morgan also engages in a lot of math talk in her classroom, formative assessment with clickers, and being attuned to her students’ facial expressions. The math songs can also act as a formative assessment for Morgan:

In that class when they’re listening they will start to sing along, so that’s another sign actually that I can see that they’re getting it. So, you know the ones that are kind of, ‘What does this song even mean?’ then I know, ‘OK, I [have to] work with them a little extra.’

These practices align with recommendations for how to reduce math anxiety in students. Activities need to be student-centred and accommodate for different learning styles, and math class needs to be a positive experience (Finlayson, 2014; NCTM, 1995). This also relates to teaching math conceptually, rather than an emphasis on memorization (Cavanagh, 2006). While it is certainly important for math skills to become automatic, it needs to be ensured students understand what they are doing, and both Joan and Morgan support their learners in this endeavour as well.
Music is certainly one piece to the puzzle of helping students with math anxiety. While I had expected to find more specific benefits to learners who struggle, I was more pleased to find that teachers perceive music in the math classroom to help all students. Supporting learners with math anxiety is so complex, but music is certainly one way these teachers support not only learners who struggle but all learners in their classrooms.

4.5 Conclusion

Through the analysis process, four main themes emerged. The most important factor influencing teachers’ use of music in the math classroom is their own comfort level with music and how they value it as a subject. This is supported by their integration of music into other subjects, as well as a perceived lack of integration of music by other teachers, teachers who are not comfortable with music. While some articles have been written with these teachers in mind, it seems as though if a teacher is not comfortable in music, they will not seek it out as a tool to help their students. More work needs to be done on how to make these resources more accessible for teachers who do not use them.

Secondly, I found that teachers’ main use of music in their math classroom was through songs that convey math concepts. Whether taking a resource from the Internet or creating one themselves, the participants found these songs to be a helpful way for students to review and remember concepts. They also felt that the mathematical nature of music indirectly supports students’ math development. While these teachers may not make as much use of music activities that draw on the deep connection between music and math, their use of music to begin with is helping students subconsciously. Based on the literature review, I had thought I would hear more examples of those deep connection musical math activities. This could be due to many factors, but I feel it is important for all teachers to be encouraged to use them more in their math
programs. While the exposure to music is surely helpful, students could gain a deeper understanding through richer activities. Not only is there a problem of bringing music into math classrooms, but for the classrooms it is already in, how can we ensure meaningful activities become regularly used.

Next, I found that teachers perceived music in the math classroom to be beneficial for all learners, not just learners who struggle. In the primary years, music helps build a sense of community for Joan’s students, while for Morgan’s high school students, music can be used to help students self-regulate. These positive benefits make the case for why all teachers should incorporate a bit of music into their math class.

Finally, I found that music is one way teachers help support learners who struggle in their classroom. From their own experiences, both Morgan and Joan found that math learning needs to be done in a community. One way Joan makes her students feel they are part of a community is through the use of song, but also allowing students to demonstrate their learning in whatever way makes sense to them. For Morgan, music can help cue students to mathematical processes, while she will also take the time to explain concepts many different ways to help her students understand.

I had initially approached this research paper with the idea that music and math would be beneficial and used to help students with math anxiety because of the many inherent connections between the two disciplines. What I found, however, is that the participants use music because of a love and value of music, and they happen to teach math, not because of music and math specifically. Through their use of music, however, classroom community is created, which is especially important in the math classroom, and all students, not just those with math anxiety, are able to learn and deepen their understanding in a safe environment. Going forward, more
research needs to be done on how to make music’s integration into the math classroom more accessible to all teachers, especially those without a music background, as it builds community, helps students learn, and creates a feeling of “pure joy.”

Next in Chapter 5, I discuss broad and narrow implications for these findings, give recommendations and note potential areas of further research.
Chapter 5: Implications

5.0 Introduction to the chapter

Chapter 5 expands upon the discussion of findings as a result of the question, “Can the integration of music into teachers’ math programs help to address math anxiety for learners and teachers?” After reviewing the findings in the context of the literature, the implications of these findings for the education community and myself as a teacher are discussed, followed by recommendations for increasing the use of music to teach math and address math anxiety. Finally, directions for future research are suggested.

5.1 Overview of key findings and their significance

The findings of the present study echo those of the literature. Four main themes emerged from the research:

1. Factors influencing the use of music in the math classroom,
2. Use of music in the math classroom,
3. Music’s effect on students in the math classroom, and
4. Supporting learners with math anxiety.

What follows is a description of each theme along with its connection to the literature.

While it was anticipated that teachers would bring music into math due to the connections between the two subjects, the most important factor influencing teachers’ use of music in the math classroom is their musical comfort and background. Both participants spoke to an appreciation for and comfort with music which lead them to not only use music in the math classroom, but to use music in other subjects as well. Being a kindergarten teacher, Joan integrates music in all subject areas, for example, delivering a lesson that uses the patterns in music to echo the patterns in the syllables in students’ names. Morgan teaches math and French
in high school, and uses music in the French classroom by exploring popular songs to examine social issues and build vocabulary. Both participants also noted their perceived lack of musical integration into math by other teachers. While other teachers support participants’ use of music in the math classroom, the other teachers do not feel comfortable enough with the subject to make use of music themselves. While much literature (e.g., Geist and Geist, 2008; Church, 2006) discusses the justification for using music in the math classroom in accessible language, the present study indicates that teachers’ comfort level with music is still the most important factor in their decision to integrate it into their math programs.

The main use of music in the math classroom by teachers was through songs that convey mathematical concepts. Joan creates songs herself that illustrate and support students’ understanding of given math concepts, while Morgan draws on TeacherTube, an online resource of teacher-created videos. Both teachers find that students can better remember concepts when they have a song to guide their memory and comprehension. While both participants noted that using music elements in the math classroom supports mathematical understanding, there was a lack of activities that draw on the deep connection between music and math. Many resources exist to help support teachers draw on these connections (e.g., Geist, Geist, & Kuznik, 2012; Geist & Geist, 2008; Church, 2006; Johnson & Edelson, 2003; Fernandez, 1999), but the most prevalent use by the participants was still through song.

Teachers’ perceived effect of the use of music in the math classroom was that it is beneficial for all students. Joan finds that singing with her students creates a positive affect in everyone, and Morgan finds that playing music in the background can help control the mood: engaging students with fast tempo music and keeping them calm during work periods with slower songs. This finding is supported in the literature, with numerous resources noting the
positive effects of music integration on students and teachers (Geist and Geist, 2009; Črnčec, Wilson, and Prior, 2006; Mendelsohn, 1999).

Participants employed many strategies to support learners with math anxiety, including the integration of music into the math classroom. In teachers’ own experiences with math anxiety, they both found that a sense of community helped their learning. Both Morgan and Joan relied on the support of their peers to understand and gain confidence in math. As such, they build community in their own classrooms to support students. With her kindergarteners, Joan integrates math into other subject areas, brings in song, and ensures her students feel comfortable to express their thinking in the way that feels best for them. In her high school classes, Morgan finds that students will engage with song lyrics that identify the process for completing various mathematical procedures. Morgan also uses humour to make her students feel comfortable and supports their unique ways of thinking. Literature on math anxiety supports the use of multiple strategies to aid student understanding (Finlayson, 2014; Cavanagh, 2006; NCTM, 1995).

5.2 Implications

Given these findings from the experiences of two educators in the Greater Toronto Area, the implications of the present study in the wider education community relate to the value of integrating music into the math program. In my personal professional practice, the implications relate to how I can advocate for and support teachers’ use of music to teach math.

5.2.1 Broad: The Education Community

Firstly, because of music’s contribution to the positive affective environment of a classroom, it is an effective means for supporting students with math anxiety. While numerous studies outline the connections between music and math and support their integration (Geist, Geist, & Kuznik, 2012; Geist & Geist, 2008; Church, 2006; Johnson & Edelson, 2003;
Fernandez, 1999; Mendelsohn, 1990), these findings provide evidence for this practice due to the positive affective environment created. Joan notes the “pure joy” that singing brings to her kindergarten classroom, while Morgan finds that music aids students’ self-regulation. The National Council of Teachers of Mathematics (1995) notes the importance of creating a positive math experience for learners with math anxiety. The positive environment created by music integration is integral to supporting all students, especially those who struggle.

Secondly, lack of comfort with music prevents teachers from effectively integrating music into their math programs. Joan and Morgan both had previous experience with music, and they find the integration of music into all their classes (not just math), to be a natural consequence of this experience. They also note that while other teachers support their practices, these other teachers lack the knowledge and confidence to integrate music themselves.

5.2.2 Narrow: Personal Professional Practice

Given my background and comfort with music and interest in this area, I have already and will continue to use music to teach math, not only because of the connections between the disciplines, but also because of the environment created. It will also be important, however, that I support other teachers in using music to teach math as well. If I can be an advocate in my teaching community, I will be able to support other educators and, in turn, their students.

5.3 Recommendations

The recommendations that arise out of the present study focus on what teachers can to do support their learners in the math classroom, through music and their own learning preferences. These recommendations are:

1. The value of integrating music into teachers’ math programs should be emphasized in pre-service teacher education programs. In order for teachers to begin their careers with
an understanding of the value of integrating music into their math programs, both math
and arts courses should emphasize the connections between these subjects, as well as the
benefits on student understanding and the classroom environment. Building on the
resources available (e.g., Church, 2006; Fernandez, 1999; Mendelsohn, 1990), pre-
service teachers should create integrated lesson plans and put them into practice. Being
connected with resources and gaining experience will help pre-service teachers without a
music background feel comfortable integrating it.

2. School boards and ministries of education should provide teachers with resources to help
them integrate music into the math classroom. Similar to the recommendation for pre-
service teachers, in-service teachers should be connected with resources to help them
bring music into their math classrooms. As well, teachers who do integrate music should
be encouraged to help those who do not.

3. School boards, ministries of education, and teacher educators should encourage teachers
to incorporate their passions into the math class to support learners who struggle. Music
is one way teachers can help students feel more comfortable when learning math. When
teachers bring their own learning preferences into the math classroom, students see that
all modes of learning are valid. Music is one way that students can connect to math, but it
should not be the only way.

5.4 Areas for further research

Further research should centre on the obstacles faced by teachers who do not integrate
music into the math classroom and the ways music can be used to build community. While much
research exists to persuade teachers to use music in the math classroom, additional research
needs to be done around reasons that prevent teachers from using music to teach math. If these
reasons were better understood, more could be done to support all teachers in using music to teach math. Given the finding of music’s positive effect on the classroom environment, further research could examine the ways music can build community to support learners who struggle, in math and other subjects. These two avenues would bring deeper insight into the use of music to teach math and how to help teachers implement this practice.

5.5 Concluding Comments

Mathematical thinking is an important skill that many students struggle to learn. In Ontario, EQAO math scores are dropping, and arguably more importantly, students report declining enjoyment for and confidence in mathematics (EQAO, 2014). Music offers one avenue through which students can connect to math. As well as illuminating the many structural similarities between music and math, using music to teach math brings a sense of enjoyment and community into the math classroom. For teachers with a music background, this integration is second nature. Teacher education programs, school boards, and ministries of education need to make resources accessible to help all teachers feel comfortable with this integration. To learners with math anxiety, mathematics can feel like an impenetrable fortress; music may be an important key for understanding the mysteries of mathematics.
References


Appendix A: Letter of Consent

Date: November 9, 2015

Dear [Research Participant],

My Name is Kathryn Bryce 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 the integration of music into teachers’ math program delivery to address math anxiety in students. I am interested in interviewing teachers who have experience integrating music into their math lessons, and who have observed the effects of those lessons on students who struggle in math or who suffer from math anxiety. I think that your knowledge and experience will provide insights into this topic.

Your participation in this research will involve one 30-45 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 and/or potentially at a research conference or 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. This data will be stored on my password-protected computer and the only people who will have access to the research data will be my course instructor Ken McNeilly. 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. 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 or benefits to participation, and I will share with you a copy of the transcript 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,

Kathryn Bryce
(416) 799-6024
kathryn.bryce@mail.utoronto.ca

Course Instructor’s Name: Ken McNeilly
Contact Info: kenneth.mcneilly@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 Kathryn Bryce 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 Questions

Section 1: Background Information

1. What do you teach? Where do you teach?
2. How long have you been a teacher?
3. What is your music background? Have you studied music formally?
4. What is your experience teaching mathematics?

Section 2: Teacher Practices

5. How are you integrating music into your math program delivery?
   a. Do you use music throughout your math program or only for specific topics?
6. Can you describe a lesson or a unit in which you’ve used music to teach a mathematical concept?

Section 3: Beliefs and Values

7. Can you tell me a bit more about your experience with math anxiety?
   a. How do you recognize it in your students?
   b. Have you experienced it yourself?
8. Why did you begin using music as a teaching tool for math?
   a. Was there something unique about the two disciplines in particular?
   b. Do you use music or the arts as a teaching tool in other subjects?
9. What effect has integrating music into your math program had on you and your students?
10. Do you believe integrating music and math has any specific effect on learners who suffer from math anxiety?
   a. What evidence do you have for these beliefs?
11. What other approaches do you take to help students who suffer from math anxiety?

Section 4: Influencing Factors

12. What kind of feedback have you had from people outside the classroom on your use of music to teach math?
13. Do you know of any other educators who use music or the arts to teach mathematics?
   a. What do you think motivates them to do so?

Section 5: Next Steps

14. What resources (organizations, researchers, studies, websites) do you use to teach math through music?
15. What advice would you give to teachers looking to integrate music into their math program delivery?