Integrating the Arts in Mathematics Teaching

By

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Integrating the Arts in Mathematics Teaching

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Integrating the Arts in Mathematics Teaching

Abstract

Mathematics education has moved to the forefront of education requiring direct and specific action to improve student mathematical accuracy and understanding. An arts-based approach to mathematics provides an invaluable addition to the mathematics classroom as it addresses the multiple ways of understanding and expressing knowledge. Recent literature appears to emphasize the positive impacts of arts integration in the classroom. Mason et al. (2005) note, based on a study of the impact of arts education on social, cognitive, and academic skills, “the more math teachers integrate arts into mathematic lessons, the more students gain on their math tests” (p.4). As Kosky and Curits (2008), Gullat (2008), and Werner (2001) suggest, there is a positive relationship between arts integration and academic achievement and participation. That is, students who are taught through arts integration tend to be more actively involved in the process of learning and tend to score higher on various levels of assessment. This research used a best practices approach and semi-structured interviews to delve into the practices of four educators in various locations across Ontario. The findings of this research were grouped into four central themes: 1) Arts are Everywhere; 2) The Teacher Approach to Arts Integration Matters; 3) Multiple Intelligences and the Foundation of Differentiated Instruction; and 4) Increased Student Engagement + Flexibility = Increased Opportunity for Learning. It is the hope of this research to show new and experienced teachers the perceived benefits of an arts based mathematics program on student achievement and engagement in math. Additionally, this research strives to provide educators with the tools and an introductory framework for implementing an arts based approach to math in their classrooms.
# Integrating the Arts in Mathematics Teaching

## Table of Contents

**Chapter 1: INTRODUCTION** ................................................................. 5  
  * INTRODUCTION TO THE RESEARCH STUDY ................................................. 5  
  * PURPOSE OF THE STUDY ........................................................................ 7  
  * CENTRAL RESEARCH QUESTION .......................................................... 9  
  * BACKGROUND OF THE RESEARCHER .................................................... 9  
  * OVERVIEW OF THE RESEARCH STUDY .................................................. 11  

**Chapter 2: LITERATURE REVIEW** .................................................... 12  
  * ARTS INTEGRATION IN THE CLASSROOM .............................................. 12  
  * MULTIPLE INTELLIGENCES THEORY AND THE ARTS BASED CURRICULUM ............................................................................. 13  
  * WHY ARE THE ARTS IMPORTANT? ......................................................... 17  
  * HOLISTIC EDUCATION AND ARTS INTEGRATION .................................. 20  
  * USING THE ARTS ACROSS THE CURRICULUM ...................................... 21  
  * LANGUAGE AND ARTS INTEGRATION .................................................... 21  
  * THE ARTS IN MATHEMATICS ................................................................. 23  

**Chapter 3: METHODOLOGY** ............................................................. 25  
  * PROCEDURE .......................................................................................... 25  
  * INSTRUMENTS OF DATA COLLECTION .................................................. 26  
  * PARTICIPANTS ...................................................................................... 26  
  * DATA COLLECTION AND ANALYSIS ..................................................... 27  
  * ETHICAL REVIEW PROCEDURES ......................................................... 28  
  * LIMITATIONS ...................................................................................... 29  
  * STRENGTHS OF THE RESEARCH DESIGN ............................................ 30  

**Chapter 4: FINDINGS** ........................................................................ 31  
  * MEETING THE PARTICIPANTS ............................................................... 31  
    * ANGELINA ......................................................................................... 32  
    * SARA ............................................................................................... 32  
    * JULIA .............................................................................................. 32  
    * JASON ............................................................................................. 33  
  * EMERGENT THEMES ............................................................................ 33  
  * ARTS ARE EVERYWHERE ...................................................................... 34  
  * TEACHER APPROACH MATTERS ......................................................... 35  
    * CURRICULUM MATTERS ................................................................. 36  
    * TEACHER ATTITUDE ........................................................................ 37  
    * HOLISTIC TEACHING ........................................................................ 39  
  * MULTIPLE INTELLIGENCES AND THE FOUNDATION OF DIFFERENTIATED INSTRUCTION ......................................................... 41  
  * INCREASED STUDENT ENGAGEMENT + FLEXIBILITY = INCREASED OPPORTUNITY FOR LEARNING .............................................. 42  
    * SAMPLE LESSONS ............................................................................ 45  
    * GRADE 2 FRACTIONS & NOTE VALUES ............................................. 45
Integrating the Arts in Mathematics Teaching

GRADE 3 PATTERNING & MUSIC PERFORMANCE ................................................................. 50
GRADES 1-3 PATTERNING, MUSIC & VISUAL ARTS ......................................................... 53

Chapter 5: DISCUSSION ....................................................................................................... 57
INTRODUCTION .................................................................................................................. 57
FROM THEORY TO PRACTICE ......................................................................................... 57
WHY INTEGRATE THE ARTS IN MATHEMATICS TEACHING? ...................................... 57
MULTIPLE INTELLIGENCES ............................................................................................. 58
HOLISTIC EDUCATION ...................................................................................................... 59
HOW TO INTEGRATE THE ARTS ...................................................................................... 60
IMPLICATIONS/RECOMMENDATIONS .............................................................................. 61
LIMITATIONS ...................................................................................................................... 61
FURTHER STUDY ................................................................................................................. 63
CONCLUSIONS ..................................................................................................................... 64

APPENDICES: ...................................................................................................................... 65
CONSENT FORM .................................................................................................................. 65
INTERVIEW QUESTIONS ..................................................................................................... 67
SAMPLE STUDENT WORK ................................................................................................. 69

REFERENCES: ..................................................................................................................... 70
Chapter 1
Introduction

Introduction to the Research Study

Mathematics education has moved to the forefront of education requiring direct and specific action to improve student mathematical accuracy and understanding. An arts based approach to mathematics provides an invaluable addition to the mathematics classroom as it addresses the multiple ways of understanding and expressing knowledge. As multiple intelligences theory suggests, there are many different ways of knowing, and the arts present a way to tap into these ways of understanding and learning information (O’Donnell, 2008, p. 117). Through the integration of the arts into the curriculum, all of the multiple intelligences are infused with the more traditional verbal/linguistic and logical/mathematical intelligences, allowing for a more comprehensive and inclusive learning environment for students. This is not to equate arts integration with multiple intelligences theory; however, research suggests that arts integration can be a useful tool in creating a classroom that addresses all or most of the intelligences of students. Recent literature appears to emphasize the positive impacts of arts integration in the classroom. Mason et al. (2005) note, based on a study of the impact on arts education on social, cognitive, and academic skills, “the more math teachers integrate arts into mathematic lessons, the more students gain on their math tests” (p. 4). As Kosky and Curits (2008), Gullat (2008), and Werner (2001) suggest, there is a positive relationship between arts integration and academic achievement and participation. That is, students who are taught through arts integration tend to be more actively involved in the process of
Integrating the Arts in Mathematics Teaching

learning and tend to score higher on various levels of assessment. Creating an environment that uses cross-curricular teaching to harness student skills creates a unique and engaging classroom environment. Accordingly, Mason et al. (2005) noted in their study that, “participants enthusiastically described how music, visual arts, and drama have impacted individual children and youth. According to participants, through arts activities students gained and demonstrated skills in problem solving, sequencing, following direction, teaming, communicating, planning and organizing, and self-assessment” (p.2).

Much of the research focuses on arts integration in social studies and literacy curricula but rarely addresses the impact on science and mathematics. Because it is evident that arts integration is important to student learning and success, it is imperative that the specific academic knowledge in the area of arts integration be extended into all areas of the curriculum (Jensen, 2001). In this context, my research will investigate educators who use an arts based curriculum to teach mathematics to their students. Gullatt emphasizes a number of methods, first introduced by J.Davis (1999), that can be employed to use the arts in other areas of the curriculum. Two of these approaches will be the focus of this research. First, an arts based curriculum is one that involves “the arts as a required core subject in the school curriculum. Using this medium, skills taught through the arts are transferred to skills in other academic areas” (Gullatt, 2008, p.14). This research will also draw on the arts-injected approach which includes “arts activities that are integrated into the general curriculum in order to enhance a particular study with no requirement of specific content studied” (Gullatt,
Integrating the Arts in Mathematics Teaching

2008, p.14). Though this research will draw on both the arts based curriculum and the arts-injected methods of inclusion, it will only refer to the use of an arts-based approach to the curriculum.

Previous research has identified the positive correlation between arts integration in teaching and student success, primarily in literacy. However, less attention has been paid to the benefits of an arts integrated approach to mathematics in the classroom. There is a lack of specific case studies that support the steps to creating and implementing a meaningful arts based curricular approach to mathematics. The purpose of this research is to delve into the best practices of educators who use the arts to teach the mathematics curriculum. There are a number of ways students can express their mathematical knowledge, and the arts provides many outlets (dance, drama, music, and visual arts) through which students can accomplish this. As Veenema and Gardner suggest, “[i]f individuals do differ from one another and if we want to reach as many of them as possible, it makes little sense to treat everyone in a one-size-fits-all manner. Rather, we need to understand the specific minds involved in an educational encounter; and insofar we should base our education [...] on that knowledge” (1996, p.70). There are a range of uncertainties when it comes to the implementation of an arts based curriculum; however, this research seeks to add to the new and experienced teachers’ understanding of the perceived successes in teaching math through the arts.

Purpose of the Study

Recently there has been increased interest in mathematics education in Ontario particularly due to the decrease in student scores on Education Quality and
Integrating the Arts in Mathematics Teaching

Accountability Office (“EQAO”). Annual test scores from EQAO tests showed only 56% of grade 6 students meeting the provincial standard from 62% of students meeting the standard in 2009 (The Star). There have been many suggestions as to how math scores can be improved across the province but no definitive plan has been developed. It is evident that students need an alternative approach to their mathematics education that makes their learning tangible and relatable to real life experience. The intention of this research is to evidence how bringing the arts into the mathematics classroom can provide an alternative means for students to learn, understand and to express their knowledge. It is important to explore mathematics education through an alternative lens to ensure students are being fully immersed, in a meaningful way, in their learning. It is the hope of this research to show new and experienced teachers the perceived benefits of an arts based mathematics program on student achievement and involvement in math. Additionally, this research strives to provide educators with the tools and an introductory framework for implementing an arts based approach to math in their classrooms.

As teachers we need to ensure students are receiving the best education possible suiting their particular needs. Students rely on the educators around them to know what is in their best interests, what will benefit them, and the best way they can be their most successful self. This research strives to share the exemplary cases of educators who use the arts to allow students to be fully involved in their mathematics education in a meaningful and exciting way.
Integrating the Arts in Mathematics Teaching

Central Research Question

The purpose of the proposed study is to explore the ways in which educators are employing an arts based curriculum in mathematics and to examine the perceived benefits of these practices. This research will also provide a framework for educators on the ways in which an arts based educational program in mathematics can be created and implemented in the classroom. The research questions guiding this study will be:

How do elementary school educators teach mathematics through the arts? What factors support the perceived successful arts based curriculum in math? What perceived benefits do these educators see for students being taught mathematics through the arts?

Background of the Researcher

Involvement in arts based activities was an integral part of my life growing up. I was heavily involved in music and drama programs beginning at the age of five. However, for me, music and drama were a simple hobby and extra-curricular activity that was done outside of school. Even during the school day, music, drama, and dance were isolated subject areas taught only when extra time was found. It was not until I began high school that I realized the influence that the arts could have on learning. Being involved in an arts program during high school allowed me to begin to understand the importance of the arts in the lives of students. By studying music I was able to learn the historical significance of certain musical pieces and how the circumstances of this time period influenced the way the music was being written. I also began to understand
Integrating the Arts in Mathematics Teaching

various elements of writing through the way lyrics in songs were written. Writing and understanding lyrics allowed me to gain an understanding of poetry, descriptive language, and conveying meaning through words among other conventions of writing and language. As I learned to understand time signatures and music notation more deeply, I began to see the connections with math, particularly fractions. It became easier for me to understand various mathematical concepts that I found difficult when disconnected from other areas of the curriculum and particularly a disconnect with the arts.

When I began to pursue a career in teaching, I sought out opportunities that would allow me to work within a school setting. I was given an opportunity in a school with an integrated arts program. The students in the arts program at this school were taught many subjects through the lens of arts education. For example, math was taught through dance and literacy through visual arts. I saw how the students flourished while in the program, and I saw the same connection between their love for the arts and their academic curriculums that I had during my high school education. I began to work with the teachers of the arts program and attempted to understand their approach to education, or better, their philosophy of education. Each teacher was dedicated to using their students’ crafts in their arts to better their understanding of the academic curriculum and allow them to use their creativity to flourish. My past experiences and knowledge of cross-curricular teaching through the lens of a teacher planted the seed for a research project that sought to understand how all teachers can create a program
Integrating the Arts in Mathematics Teaching

that hones in on students creativity in a way that allows them to express their understanding across the curriculum.

Through my experiences, and primarily my experience in the arts integrated school, I began to wonder how all educators could use the arts to teach their students in a way that is engaging, creative, and outside of the traditional educational box. What is it about the arts that engages students and makes them active in their learning? Because of my past experiences both as a student and as an educator, I have developed a desire to seek the tools arts integrated educators use to teach an arts integrated curriculum, specifically in the area of math. Throughout my research, I hope to learn how these educators develop and implement an arts integrated program that can be used by teachers in multiple educational settings. However, throughout my research I will be mindful to not allow my personal bias towards arts integrated education influence the findings.

Overview of the Research Study

This research study will begin with a review of the existing literature in Chapter 2. This chapter will outline some of the significant themes and findings of past research that establish the importance of understanding and implementing an arts based curriculum. Chapter 3 will provide an overview of the research study’s methodology. This chapter will speak to the procedure used, the instruments of data collection, the participants, data collection and analysis, and the ethics review procedures. Chapter 4 will encompass the findings of the research study. Finally, Chapter 5 will provide a discussion of the research study, emphasizing the implications of the research and the
Integrating the Arts in Mathematics Teaching

recommendations that stem from the research findings. This final chapter will also address further studies and questions that have arisen from the present research study.

**Chapter 2**

**Literature Review**

**Arts Integration in the Classroom**

The integration of the arts into the classroom involves bringing dance, drama, music, and visual arts into all areas of the curriculum. J. Davis developed a number of ways the arts can be integrated into the classroom. The three that will be of interest to this research study, as mentioned earlier, will be an arts based and arts injected approach to integrations and the aesthetic education model. Briefly, an arts based approach involves the arts being a required core subject in the curriculum. Using the arts as a medium, students use the skills acquired in their arts classes in other subject areas (Davis, 1999). Additionally, the arts injected approach uses the arts to enhance various areas of the curriculum (Davis, 1999). Finally, the aesthetic education model allows educators to use the arts as a way for students to exemplify their particular ways of knowing and constructing that knowledge in alternative forms (Davis, 1999). In combination, these approaches are comprised to form the understanding of an arts based approach to the curriculum for the use of this research paper. The arts are used in the classroom as a way for students to make meaning of their learning and as a way for them to express their learning.

Arts integration stems from the notion that the arts play a significant role in keeping students engaged in education by encouraging their learning through a physical and embodied way. That is, arts invite students “to collaborate with peers, by requiring
Integrating the Arts in Mathematics Teaching

them to respond emotionally and by calling upon their cognitive capacities as they learn in, through and about the arts” (Upitis, 2011, p.1). The Royal Conservatory of Music developed the “Learning Through the Arts” (LTTA) initiative in 1994. The program is based on the principles of an arts based curriculum that are the basis for the approach being studied in this research paper. The program “uses arts-based activities to teach the core curriculum by providing teachers with creative tools to engage all students in math, science, language arts, [and] social studies” (Royal Conservatory of Music, 2014). This program teaches educators to work creatively to make lessons that make a core curriculum that is exciting and relevant (Royal Conservatory of Music, 2014). With this, the “hands-on programs fuse the arts, cognition, and curriculum in multiple learning paradigms” (Royal Conservatory of Music, 2014). Learning through the arts or an arts based approach to the curriculum would involve activities such as those suggested by Catterall (1998). For example, students would take part in activities such as dramatizing historical events or using paintings to explore various time periods (Catterall, 1998). An arts based approach to the curriculum as suggested above impacts students on multiple levels and students with various learning styles and abilities.

Multiple Intelligences Theory and the Arts Based Curriculum

Students learn using multiple styles and systems of knowing. No two students learn or express their learning in the same way. In fact, “the mind is not comprised of a single representation or even a single language of representation. Rather, all individuals harbor numerous internal representations in their minds” (Veenema and Gardner, 1996, p.70). That is, teachers must first realize that there is diversity in learning to understand
Integrating the Arts in Mathematics Teaching

that there is a need for a diversity of teaching methods and styles. Howard Gardner developed the theory of multiple intelligences to encourage teachers to “adjust their instructional strategies in order to meet students’ individual needs” (Nolen, 2003, p.115). Gardner (1996) posits that there are a number of styles through which students learn and express their knowledge. He suggests that there are “at least eight discrete intelligences, and these intelligences constitute the ways in which individuals take information, retain and manipulate that information, and demonstrate their understandings (and misunderstandings) to themselves and others” (Veenema and Gardnery, 1996, p.70). Veenema and Gardner (1996) suggest that schools have a tendency to favor the logical and linguistic thinkers and those who rely on other mental representations struggle to excel in this environment. This research then, will provide insight into the purpose of extending the boundaries of this traditional way of knowing and allowing students the opportunity to harness their individual way of knowing. For Veenema and Gardner, “if one wants to educate for genuine understanding, then, it is important to identify these representations, appreciate their power, and confront them directly and repeatedly. Only then is it possible, in a reliable manner, to construct more adequate mental representations that themselves become robust and enduring” (1996, p.71). In the context of this research, addressing the mathematics curriculum through a lens based in the arts will hone in on students’ particular skill sets and make their learning concrete and meaningful.

Five of the identified intelligences, as most notably presented by Nolen (2003) are pertinent to understanding the importance of the arts in the mathematics
Integrating the Arts in Mathematics Teaching

classroom. The first identified intelligence is verbal linguistic intelligence. Individuals with this particular intelligence tend to think in words and have “highly developed auditory skills” (Nolen, 2003, p.115). These individuals memorize best using words and have the ability to explain their thinking coherently and logically. Teachers teach the verbal linguistic learning through the use of language that is easily understood by the learner. For these students, language is the bridge between the learning and the learner (Lazear, 1992; Nolen 2003). Musical intelligence is identified next. Individuals with musical intelligence make use of sound and have a “firm understanding of pitch, rhythm, and timbre. Through music, they are able to convey their emotions” (Nolen, 2003, p.116). Additionally, music acts as a medium where individuals can express their emotions and begin to understand and know their feelings (Nolen, 2003, p.116). Additionally, Gardner identifies mathematical-logical intelligence where an individual strives at identifying and detecting patterns and thinks logically about the world around them (Nolen, 2003, p.116). Mathematicians have the ability to recognize patterns in the most abstract form, wherever they may be (Nolen, 2003). Spatial intelligence is noted next by Gardner. These thinkers “perceive the visual world accurately, to perform transformations and modifications upon one’s initial perceptions, and to be able to re-create aspects of one’s initial perceptions, even in the absence of physical stimuli” (Nolen, 2003, p.116). Related to the desire to use the concrete world to make understanding for the spatially intelligent individuals is the bodily-kinesthetic intelligence that demands for an understanding of the world through the body (Nolen,
Integrating the Arts in Mathematics Teaching

2003, p.117). Teaching children with this particular intelligence is optimized through the use of manipulatives and bodily movement (Nolen, 2003, p.117).

As a result of the above discussion I would like to suggest that each of the intelligences identified by Gardner can be related or tied to the arts. Musical and verbal linguistic intelligences are closely related. That is, within a student’s ability to learn language and express through language, they have also developed the ability to understand and express musical pieces and lyrics. Additionally, individuals with musical intelligence or the ability or desire to learn through music are also connected to mathematics. Musical and mathematical intelligences are closely intertwined as music contains “ratio and regularity, as well as mathematics patterns” (Nolen, 2003, p.116).

Music and dance have their roots in simple and complex patterns and it is children who have mathematical intelligence that are most adept to identify and understand these patterns. Their love for mathematical logic and reasoning can be extended and nurtured in the realm of the arts. Furthermore, individuals with spatial intelligence have a clear connection with visual arts. As Nolen suggests, “painting and sculpting often rely on spatial thinking. An artist’s style often depends on their ability to visualize and create from a blank canvas” (2003, p.117). Children with this particular intelligence learn best through pictures and diagrams that can be used to enhance their learning of mathematical concepts. Furthermore, students with spatial intelligence will excel in dance and the dramatic arts. Both of these mediums require the performer to be aware of their surroundings and use space to convey a particular meaning through their body. In addition, the bodily-kinesthetic intelligent child will be able to use their bodies in
Integrating the Arts in Mathematics Teaching

dance to feel and understand the math behind the movement. In fact, one of the most common professions for an individual with this particular intelligence is that of a dancer. That is, “dancers use patterned sequences of nonverbal body movements that are purposeful, intentionally rhythmic and have aesthetic value in the eyes of those for whom the dancer is performing” (Nolen, 2003, p.117). The rhythm that is felt through these individuals can be teased out in musical, dramatic, and dance lessons that allow them to express math through the body.

It is evident that each of the intelligences has roots and connections in the various streams of the arts. This research will delve into the ways the arts can be weaved into the mathematics curriculum. Ultimately this will allow for a connection between mathematics and the variety of intelligences students will possess.

Why Are the Arts Important?

The arts are a part of human development and life that is invaluable. According to Eric Jensen, the arts have a unique role in shaping humans. He asserts “arts are not only fundamental to success in our demanding, highly technical, fast-moving work, but they are what makes us most human, most complete as people” (Jensen, 2001, p.vii). The arts serve a purpose for individuals both socially and emotionally. Socially, students who are exposed to the arts connect to one another better; there is “greater camaraderie, fewer fights, less racism, and reduced use of hurtful sarcasm” (Fiske, 1999 as cited in Jensen, 2001, p.3). The arts allow individuals to develop an awareness of and a tolerance for difference (Jensen, 2001, p.5). They are also a vehicle for cultural expression and an understanding of cultural identity both for oneself and for others.
Integrating the Arts in Mathematics Teaching

(Jensen, 2001, p.5). The arts reach all students regardless of level of development, socioeconomic status, and position in the classroom environment (Fiske, 1999). Research has suggested that when students lack exposure and education in the arts they are disconnected from history and culture and other forms of expression (Cornett & Smithrim, 2000). Finally, the arts provides an escape for students struggling in their everyday lives. Cornett and Smithrim suggest, “the arts can be a feel good alternative for students who turn to drugs and other destructive means to get high” (p. 23). The arts act as a support for students and are consequently related to preventing dropout and keeping students in school (Cornett & Smithrim, 2000).

The importance of the arts extends beyond a social and emotional level and impacts human neurobiological development (Jensen, 2001). That is, when an individual is engaged with the arts, they are activating and simultaneously developing multiple brain systems (Jensen, 2001). Jensen explains “the systems [the arts] nourish, which include our integrated sensory, attentional, cognitive, emotional, and motor capacities, are, in fact, the driving forces behind all other learning” (Jensen, 2001, p.2). Simply said, the arts help develop the brain. Cognitive science further exemplifies the importance of arts integration for students. Theories in cognitive science assert that connections are the basic core of cognition and consciousness which is suggested to be directly related to the gains made by students when they are taught using the arts (Marshall, 2005). One theory, which further supports this notion, is the Neural Network Theory. This theory, first introduced by Hopfield in 1982 “indicates that cognition occurs when neural nodes in the brain are activated simultaneously in net-like configurations”
Integrating the Arts in Mathematics Teaching

(Marshall, 2005, p.229). These neural connections are intrinsically connected to the conceptualizations created in the mind validating the integration of arts because this integration is based on making connections between curriculum and the arts (Marshall, 2005). Each of the particular arts has a direct influence on the composition and development of various structures in the brain. Neurobiological systems are all enhanced through engagement in music, visual arts, drama, and dance. The key areas of the brain that are impacted by music and learning to play instruments is the same area of the brain that influences performance in math (Jensen, 2008). Further, the “neural symphony theory” posits that “music may activate and synchronize brain activity” (Jensen, 2008, p.28). Additionally, visual arts requires the artist to activate both sides of the brain as the right and left hemisphere are important for creating images (Jensen, 2008). Finally, the kinesthetic arts, or drama and dance, impact the brain simply through the physical activity that is necessary to perform. Jensen (2008) suggests one indirect benefit is that it facilitates the maturation of the brain’s cortical systems. This is especially important for enhancing student learning. Reading, counting, speaking, and problem-solving are all maturation correlated” (p.76).

Beyond the influence of the arts socially, emotionally, and neurobiologically, there is a connection between academics and exposure to the arts. Cornett and Smithrim (2000) found, “schools with strong arts programs regularly incur the benefits of increased student motivation to learn, better attendance among students and teachers, increased graduation rates, revitalized faculty, greater student engagement, growth in use of higher-order thinking and problem solving skills, and increased creative
Integrating the Arts in Mathematics Teaching

capacities” (p.2). The arts allow students to connect with the curriculum and create challenges and strides for gifted students as much as it does for students who face academic challenges. That is, “[the arts] changes the [classroom] environment to one of discovery. This can re-ignite the love of learning in students tired of being filled up with facts” (Fiske, 1999 as cited in Jensen, 2001, p.3). Additionally, arts education helps students develop the skills of responsibility, focus, and self-discipline (Cornett & Smithrim, 2000). Students who are exposed to the arts are able to flourish, in a broad sense, socially, emotionally, and academically. Research has pointed not only to the general influence of the arts for students’ success and development but also to the specific benefits of the arts in particular areas of the curriculum.

Holistic Education and Arts Integration

Arts integration in the classroom helps teachers achieve an approach to education that teaches the whole child. Arts integration allows for a well-rounded approach to the curriculum and thus, allows the teacher to address the learning needs of the whole student. Understanding the arts from a holistic perspective and a pedagogy of holism also eliminates the reductionism and dualism that emerge when thinking of traditional notions of arts integration (Min, 2013). Understanding arts integration from a holistic perspective allows educators to see that it is essential in creating a unified approach to the curriculum (Min, 2013). Much like the benefits of arts integration in engaging the multiple intelligences of students as stated above, holism further promotes the engagement of student multiple intelligences and gives them a creative outlet to learn and express their knowledge. Min states, “arts are the best medium
Integrating the Arts in Mathematics Teaching

through which educators can plant, grow, and fruitfully harvest holistic ideals. In the holistic sense, art is an ongoing learning process of creating, presenting, responding, and evaluating: it is a field that covers the whole inner and outer dimensions of human life” (2013, p.211). Because the arts are an embodied practice they allow students to tap into their entire being to create and represent knowledge. The creative process outlined in the Ontario Arts Curriculum document defines the steps, as stated in the above quote by Min, that allow students to engage their entire beings in their academic journeys.

Using the Arts Across the Curriculum

Current research has indicated that the arts have a positive influence on student achievement in the classroom. As Cornett and Smithrim suggest, “art reflects life, so it naturally integrates all curricular areas” (2000, p. 141). Extensive research has been conducted to explore the benefits of arts integration in language arts instruction. However, little research has been conducted in the area of mathematics to prove the importance of arts integration in other subject areas. An examination of the current research on arts integration and language instruction provides evidence and rationale for integrating the arts in other subject areas, specifically in math.

Language Arts and Art Integration

Traditional methods of language arts instruction and assessment are based in a dominant way of thinking that confine language to written and spoken word. This removes the interconnectedness through which children experience language outside of the walls of the school. Children have diverse experiences with language and thus, the way teachers approach language instruction must “embrace children’s multifaceted
Integrating the Arts in Mathematics Teaching

ways of knowing” (Kendrick & McKay, 2004, p.109). That is, educators need to move away from the structures that confine language learning to reading and writing and allow children to express their knowledge of literacy in their particular style of representation (Kendrick & McKay, 2004, p.109). In a study conducted by Kendrick and McKay, students were given the opportunity to express their understanding of literacy through drawing. They found that “the teachers were overwhelmingly surprised that their students were able to express complex understandings of reading and writing, which were apparently not evident in classroom language arts activities” (2004, p.123). Thus, the arts allows students to represent their literacy knowledge in a way that is comfortable to them. They were able to express more about their understandings when no longer constrained by reading and writing. The drawings allowed students to express beyond what written words would allow. They were able to “represent whole areas of their sensory lives” (Kendrick & McKay, 2004, 123). The students were able to bring in their knowledge of taste, hearing, smell, and touch to create a holistic picture of their understanding of the language arts curriculum.

Further research has identified that the arts provide an alternative way for students to understand the fundamentals of language. Music, drama, dance, and visual arts act as a medium that allows students to grasp the basis or fundamentals of language arts. Before students can be avid readers and writers, they need to have a strong grasp of the conventions of language. Many researchers have suggested that the arts are a few of the caveats to this formal understanding of language. Paquette and Rieg (2008), in a study looking particularly at music and English language learners’
Integrating the Arts in Mathematics Teaching

experiences, found that consonant sounds, sentence patterns, vocabulary, pronunciation, rhythm, and parts of speech were reinforced through music. They discovered that music provided an added motivation for students to learn these complex processes. Additionally, they noted that “song picture books also support emergent literacy development by building on familiarity and enjoyment, providing repetition, expanding vocabulary and teaching story structures, promoting critical thinking, and fostering creative expression” (Paquette & Rieg, 2008, p.230). Similarly, McMahon, Rose and Parks (2003) found that using dance to teach their language arts program “was so successful in the areas of consonants, vowels, and overall phoneme segmentation, that BRD students started out lower than control students and then actually performed better than the control students on the posttest” (p.119). It is evident that students who are given the opportunity to use the arts to assist them in building their understandings of the fundamentals of language are able to thrive as a result. The research suggests that the arts have a positive impact on literacy learning for students and thus points to the idea that there may be benefits for this type of instruction in other curriculum areas. Most of the research points to strides made in the language arts classrooms, however, there is evidence to suggest that the benefits extend into the mathematics classroom.

The Arts in Mathematics

Understanding the role that the arts play in mathematics education has not been at the forefront of current research. However, some researchers have provided small insights into the positive impacts arts integration has on this area of the curriculum. In
Integrating the Arts in Mathematics Teaching

1999 Cossentin and Shaffer conducted a study that explored arts integration and math. The students in the study were given the opportunity to explore symmetry and composition from a mathematical and aesthetic perspective (Gullat, 2008). As a result of the project, the students “were able to describe works of art in a meaningful way. In addition, the spatial skills of students were enhanced” (Gullat, 2008, p.17). The Royal Conservatory of Music, when creating the “Learning Through the Arts” program collaborated with Queen’s University to understand the impact the arts had on student learning. This study found “students in the [Learning Through the Arts] program scored an average of 11 percentile points higher in math than their peers in non-LTTA schools” (Royal Conservatory of Music, 2014). This study exemplifies how the arts increased students’ academic performance. However, the study does not provide a specific instruction for non-arts trained educators to employ a similar program. The current research study will fill this void and provide the stories of educators who have implemented their own arts programs in their mathematics classroom in a way that is easily transferable to other mathematics classrooms.
Integrating the Arts in Mathematics Teaching

Chapter 3
Methodology

Procedure

This research study used a qualitative research approach to investigate the ways in which arts educators used the arts to teach mathematics. Qualitative research provides a unique lens to approaching a topic or area of interest for a study. As Creswell suggests:

[...] qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations [...] This means qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. (Creswell, 2013 p. 44)

By conducting qualitative research, we are empowering individuals to share their stories and experiences and have their voices heard to allow for a growth of knowledge and understanding of particular areas of interest.

This research study employed a qualitative research design, drawing on characteristics of narrative, phenomenological, and grounded theory approaches. This study privileged the lived experiences of the participants and their stories of how they came to a teaching career based in arts education. I drew on participants’ oral histories to allow for an understanding of cause and effects based on personal reflections (Creswell, 2013). Drawing on the oral history and lived experiences of the participants was important for this study because it allowed for the phenomenon of integrating arts
Integrating the Arts in Mathematics Teaching

and mathematics to be unpacked. This research sought to develop a theory or discovery of the ways arts educators implemented an arts based program in mathematics.

Instruments of Data Collection

I conducted semi-structured interviews with four consenting participants. Each interviewee participated in a 45-minute interview. The interview questions (Appendix B) were designed to learn about teachers’ rationales and strategies for implementing an arts based mathematics programs. Additionally, the questions were aimed at understanding the complexities, highlights, and challenges of such a program and the perceived benefits that this type of educational experience has for student success.

Research Question: How do elementary school educators teach mathematics through the arts?

What perceived benefits do these teachers observe for students?

These questions allowed for thorough discussion of the process involved in creating an arts based mathematics program. The participants were able to highlight the steps they took when creating their program, opposition they were faced with and how this was overcome, and the perceived benefits for students who are involved in an arts integrated math program. See Appendix B for sample interview questions.

Participants

This research study is based on the best practices method of research. That is, the study focuses on exemplary cases of arts integration in math. The participants were selected based on criterion sampling where all participants were required to meet specific criteria in order to participate in an interview. All participants were required to
Integrating the Arts in Mathematics Teaching

have used the arts in their mathematics curriculum. The teachers did not have to consistently use the arts but must have evidence of using the arts in a meaningful way to assist their students in their understanding of mathematical concepts. That is, the teacher must have student work samples that evidence the students using the arts to enhance their understanding of or communication about a particular concept or theme.

Four participants were selected for this research to ensure that each of the arts streams (music, dance, drama, and visual arts) were included in the study.

All participants for this study were recruited through recommendations by principals or other education staff. An individual who knew that the teacher used the arts in their classroom made each recommendation. They had also personally witnessed the teaching and learning of mathematical concepts through the arts. This may have been seen on one or more occasions. The participants were not required to have a certain portion of their mathematics curriculum taught using the arts, but were required to have positive feelings towards using the arts in the mathematics classroom.

Data Collection and Analysis

I conducted a review of the literature and semi-structured interviews with four teachers. The literature review synthesizes the works of various authors who have studied arts integrated education, alternative mathematics teaching, challenges to arts integrated education, current trends in mathematical education, and the strengths and weaknesses of conventional teaching methods in mathematics.

After the literature review was complete, I created an interview protocol to be used during face-to-face semi-structured interviews. Forty-five minute semi-structured
Integrating the Arts in Mathematics Teaching

interviews were completed with each participant that, in line with the Ethical Review Protocol, occurred outside of school time (Kosnik, 2011). The face-to-face interviews were used to gather information on the ways the educators were introduced to the use of arts integration in math, how they have implemented an arts-integrated math program in their classrooms, supports and challenges, and finally, the perceived benefits of such a program for their students. The interviews were integral in the data collection process as they allowed the participants the time to fully articulate their feelings towards, and strategies for, arts integration in mathematics, thus making the data more authentic (Creswell, 2013).

Finally, I conducted content analysis of participants’ lesson plans, assignment guidelines, and assessment tools to learn more about their instructional decision-making when integrating the arts and mathematics curricula.

Ethical Review Procedures

This study adheres to the ethical guidelines set forth by the University of Toronto and specifically the Master of Teaching Program. In turn, the study consisted of interviews with educators without interference in the classroom environment through student observations and interaction with students. The participants were provided with a consent letter (Appendix A) that stated their participation in the study was entirely voluntary and they had the ability to withdraw at any time during or after the interview process and they had the right to pass on any interview questions they did not feel comfortable answering. This letter also ensured that the participants knew the purpose and content of the study and were provided with my (and my supervisor’s)
Integrating the Arts in Mathematics Teaching

contact information should they have any concerns or questions about participation. Confidentiality and respect for persons in the research study was of utmost importance throughout the research process. Finally, the participants were assured that their names and any identifying information would remain anonymous and they would be given pseudonyms in the research report.

Limitations

The nature of qualitative research and the ethical approvals and structures create some limitation for this study. The first limitation in this study is due to time constraints. Because the study was conducted in a short period of time, the interviews were limited to a single one-hour meeting with each participant. Due to the ethics approval limitations, this study did not involve observation of an arts based curriculum approach to mathematics in practice. That is, I did not have the opportunity to go into the class and observe the teachers implementing a program that teaches students mathematics through the arts. Nor was I able to observe how the students responded to the program. Additionally, I could not speak directly with the students, meaning that the perspectives of participating teachers may focus disproportionately on the perceived benefits for students more so than hindrances. Furthermore, the educators may be under the impression that the students are benefitting or enjoying the programs though the students’ stories may have reflected a different perspective.

Strengths of the Research Design

Though the study does not give a voice to students, the voices, perspectives, and practices of the participating teachers will be privileged and underscored as models for
Integrating the Arts in Mathematics Teaching

consideration by the broader educational community, including those interested in, but hesitant to, integrate an arts-based approach to teaching math. The perceived benefits highlighted by the participants will also give some insight into the strengths of an arts based mathematics program for students. Teacher participation was also an opportunity for them to reflect on their practice and students’ responses to it. In order for more teachers working across school contexts to integrate the arts with mathematics, it is important to learn from a sample of teachers working in educational contexts where this is supported and expected. These participants have fully immersed their educational beliefs and teaching philosophies in the arts and they have invested significant time and effort into developing arts based educational programs for their students. Finally, because attention on mathematics achievement has recently been the focus of much attention, examining new and alternative methods to teaching mathematics is an important contribution to this timely discussion.
Chapter 4
Findings

In this chapter, the findings from the data collection during the interview process will be presented and discussed. Again, the interviews explored the ways in which teachers use the arts in their mathematics classrooms and sought to discover any perceived benefits that arose from teaching math through an integrated lens. The participants clearly identified as being in favor of arts integrations and saw a multitude of benefits for students. It is clear from the participants’ responses, just as was evident in the literature, that arts integration provides a new way of exploring content that challenges and enhances student’s learning and ultimately leads to student success.

This chapter begins with a brief introduction of the participants. The purpose of the introductions is to exemplify the varied background and levels of experience in the arts that each teacher brings to this research and also the lens from which they are approaching their classroom and their responses to the interview questions. The chapter then examines the data and presents an analysis of the findings. Reviewing the data allowed for three distinct themes to emerge along with several subthemes. The main themes that will be the foundation for this chapter are: (1) arts are everywhere, (2) teacher approach matters, (3) multiple intelligences and the foundation of differentiated instruction, and (4) increased student engagement + flexibility = increased opportunity for learning. The chapter then concludes with an overview of the findings and sample lesson plans developed as a result of the interview findings.
Integrating the Arts in Mathematics Teaching

Meeting the Participants

Each of the participants interviewed for this research study are teachers in Ontario. They each came from various publically funded school boards across Ontario. For the purpose of this study the participants have been assigned pseudonyms to maintain anonymity.

Angelina

Angelina is a grade 7 teacher in the Greater Toronto Area and has been teaching for more than 15 years. When asked about her background in the arts Angelina explained that she was originally an actor who performed in multiple plays across Ontario and decided to take her love of the arts into the classroom as a teacher. She is now the arts department head at an arts based elementary school. She is both the drama teacher for the arts department and is a homeroom teacher which is where she is able to do most of her arts integration in math.

Sara

Sara has been teaching in the public education system in the GTA for 10 years. She has been a grade 1 teacher for most of her teaching career with one year spent teaching grade 6 and another as a teacher in a grade 1/2 split class. Sara has no background in the arts but stated that she loves music and dance and thought that her students would love the opportunity to be creative which inspired the beginning of her arts integrated approach.
Integrating the Arts in Mathematics Teaching

**Julia**

Julia has a significant background in the arts. She has been a dancer since the age of 3 and studied dance in a concurrent education program which first exposed her to the idea of arts integrated teaching. She has been teaching for over 10 years and is a dance specialist teacher as well as a homeroom teacher at an arts integrated school in the GTA.

**Jason**

Jason has worked as a teacher in the intermediate grades for the past 27 years. He has moved from the private to the public education system and has worked in schools with diverse socio-economic statuses. He has no formal arts background but is a drummer and percussion artist and has been heavily involved in music as a personal hobby for many years.

**Emergent Themes**

Through the interview and data analysis process three main themes emerged along with several subthemes.

*Theme 1: Arts are Everywhere*

*Theme 2: Teacher Approach Matters*

- Curriculum Matters
- Holistic Teaching
- Teacher Attitude

*Theme 3: Multiple Intelligences and the Foundation of Differentiated Instruction*
Integrating the Arts in Mathematics Teaching

Theme 4: Increased Student Engagement + Flexibility = Increased Opportunity for Learning

Arts are Everywhere

One of the most interesting findings that emerged through participant responses was the belief that arts are inherent in all curriculum areas. Many of the participants held the belief that if a teacher wants to see the arts in a concept, lesson, or assignment, the arts are present. The perspective of the teacher is what truly allows the arts to come alive in the mathematics classroom. Sara and Jason both vividly expressed the presence of arts throughout the mainstream curriculum.

Sara suggested, “[w]ell I think if you really look at it, really analyze any art activity a teacher does you can connect it to [mathematics]. [...] [I]f you just put the focus on [the math concept for] that lesson.” It is important for teachers to realize that they can take the art concept or the mathematics concept and find a relation between the two. She continued, “[...] you need to know the curriculum really really well so that way you can manipulate [arts activities] to just go back to the curriculum.” That is, knowing the curriculum and understanding what you are trying to accomplish mathematically with your students will allow you to take an arts based activity and always relate your ideas and artistic activities back to your math learning goals.

Speaking specifically about his experiences in the intermediate classroom, Jason explained, “the arts are in everything and it is up the teacher to find it. The opportunities for arts are ongoing and continue to broaden”. The arts are inherent in math and math is inherent in the arts. Jason was firm in his explanation that the arts are
Integrating the Arts in Mathematics Teaching

transferable and can be used as a launching point or an integrated supplement because of the ever-present connection between the arts and mathematics.

Teacher Approach Matters

Many of the participants alluded to the fact that the success of arts integration in the mathematics classroom begins with the teacher. Whether it is his/her philosophy of education, his/her innate characteristics, his/her personality, or his/her educational beliefs, the root of successful integration lies in the hands of a creative and an out of the box thinking teacher.

In her interview, Angelina began to deconstruct the word “drama”. She suggested “drama is the Greek word for action so it means you are often moving. So basically any of the curriculum can be taught that way”. It is evident that arts integration is more than creating a math lesson that allows students to draw or paint or create a song; it is a perspective. This perspective is rooted in the teacher’s approach and the teacher’s willingness to look at math from an alternative perspective. Further, Sara commented, “well I think if you really look at it, really analyze any art activity a teacher does, you can connect it to anything. Right, if you just put the focus on that lesson for that particular thing”. Each participant had a set of beliefs that really rooted the discussion in the teacher approach to an arts integrated curriculum being one of the most important factors in its success.

Curriculum Matters

One of the most prominent discussions that emerged within each interview was the importance of the curriculum and with that, the math curriculum matters. Each
Integrating the Arts in Mathematics Teaching

participant in their own voice expressed the importance of knowing, focusing on, and beginning with the math curriculum to create a comprehensive arts integrated lesson or unit. Julia was insistent on really knowing the math curriculum and beginning with a math concept to ensure she is “covering all necessary curriculum expectations, especially in preparation for the grade 6 EQAO testing.” Similarly, Jason commented “math is really the core subject, so most teachers in public school need to focus on that so that is always at the forefront of my thinking. I look at the specific expectations, the learning goals and the fundamental concepts and build from that when I am planning”.

Angelina also expressed a firm belief in starting with the curriculum no matter the integrated example she chose to speak to. Like Julia, Angelina suggested that because math is the core curriculum subject, it is important to look at this as the foundation for your lesson or unit. As she suggested, because the arts and particularly drama are about movement, she “start[s] with the curriculum, what do they need to know and then I thought what is a good way to get them out of their seats to do this”. To support this, she provided a lesson example where she began with the math curriculum and used the arts to further her students’ knowledge of that concept. “I look through what I have to cover in math...So I look, and see we are currently working on perimeter. So here is another example. We are doing measurement of perimeter. So, um, I happen to have a stage in my room, but you don’t have to have a stage in your room; but I asked them to walk the perimeter of the stage, but I had a supermodel walk the perimeter of the stage, then I had a 100 year old man follow her. And then we built the story.”
Integrating the Arts in Mathematics Teaching

Sara worked on a patterning unit with her students. The second time the students looked at patterning she decided they needed to be out of their seats and moving to express their knowledge. So, she asked the students to create a dance. Sara knew that she needed her students to cover patterning for the second time that year and wanted to allow her students to feel and express the concept they were learning about. In her words, the lesson emerged because:

[they already knew that patterning means it has to repeat itself and that the pattern rule is the part that repeats [...] I chose one song that was appropriate and was fun for the kids and then I told them “here is the music, you have to create a pattern and you have to keep repeating those dance moves throughout the whole song.” So then, I gave them just those rules: it has to be a pattern, you have to give at least [...] 3 or more moves and then I made them write the steps down to [...] see what the pattern is and that they are repeating it.

In this particular circumstance, the arts integration was a success because the math curriculum was at the forefront of their learning. Because Sara knew precisely what was to be covered in math, she was able to find a creative alternative for the students to express their knowledge. From this, Sara believed that the students thrived and were truly engaged in their learning.

Teacher Attitude

No matter how well a teacher knows the curriculum, if they do not have the attitude and drive to create a comprehensive arts integrated program, the mathematics classroom will remain based in traditional textbook teaching. Each participant suggested various attitudes and character traits that are imperative for a teacher to be successful when creating an integrated program. Sara is an excellent testament to the trueness of the teacher’s attitude being imperative to the success of an arts integrated math
Integrating the Arts in Mathematics Teaching

program. When she described her integrated dance and patterning unit she said, “I just think it’s fun. I like to dance. [...] Dancing is always fun so I thought that the kids would like that as well”. She finds dance enjoyable and fun and took that attitude into the class when she was presenting the integrated unit to her students. Because she had a fun and positive approach to the lesson her students were encouraged to be part of this creative way of learning.

Angelina also speaks to the importance of the teacher’s attitude when using an arts integrated approach in the math classroom. For her, it is about instinct and confidence. In order for teachers to truly embrace arts integrated lessons, they need to be confident in their understanding of the math and arts, and be confident in themselves to have fun and be quirky around their students. To explain this, Angelina provided the following example:

[...] this is the thing about the arts that I find the hardest thing [...] for me [arts integration] worked nicely because I was an actor so switching it up for the kids who aren’t getting it by singing or, or when [...] we do something like fractions and I don’t want them to touch the denominator I’ll sing ‘da na na na nana nana don’t touch this’ and I’ll hear them actually singing it when they are solving their questions because it’s reminding them ‘I don’t add the denominator, I don’t add the denominator I just need to find the common denominator’.

Arts integration is therefore a product of the teacher’s desire to have fun and find ways to tap into their students’ understanding. In order for this approach to be successful, the teacher not only has to incorporate lessons that allow the students to use the arts to express their understanding, they also need to use the arts in their everyday teaching. Just as Angelina showed, it is as much about the minor details of classroom “talk” where the students pick up key information or tricks to remembering concepts.
Integrating the Arts in Mathematics Teaching

Jason further commented on the importance of confidence when approaching arts integration in the classroom. He asserted that a teacher’s confidence is what makes arts integration possible. This is both confidence with themselves as teachers’ and their confidence in the material. These assertions also bring the discussion back to the idea that the curriculum matters. Jason was clear that it is through confidence in the math curriculum and knowing the math curriculum that a teacher can truly integrate the arts successfully. This is also furthered by his comment “I am always thinking about the art from a math perspective”. If a teacher is able to gain the confidence and is able to see the fun in the arts, he/she will be able to channel his/her thinking to see the arts emerge in math and will look at the arts from its relation to math in his/her everyday lives.

Holistic Teaching

An important finding that emerged from this research is that successful arts integrated math programs are based in a teacher’s holistic approach. That is, the arts are not more important than math and math is not more important than the arts. It is in the combination of these two areas with an equal focus given to each that allows for a truly beneficial program to be created. Many of the participants suggested that one specific approach or way of teaching does not allow students to reach their full potential. As Angelina commented, “it can’t always be pen and paper and drill and kill math practice, computation practice, [or] multiplication practice. Basic fundamental skills of math do need a pen and a paper and then you need to get those kids out of their seats”. That is, you are teaching the whole child through a curriculum that has a well-rounded basis both in math and the arts. Many participants commented on the
way a holistic arts integrated lesson or unit can be created as well as how assessment can be holistically done:

Always for my assessment in math I always do three things. [...] it would be a quiz so I do checks along the way that count for nothing except my knowledge. I’ll do a 5 question check, a 3 question check, and I’ll look at every single kids’ work to make sure they are on [the right track] just for me. That’s the diagnostic [...] of who’s getting it and who’s not. It’s [...] formative too because I am getting to see who is getting it and who is not and then there is always a quiz reinforcement and then a test and then either a math journal or a math problem. So they have a problem solving journal and a math journal.

Journals are a creative way to become the teacher. [...] [the students] create a page in the journal using pictures, words and creativity to explain [ and] teach me the concept. [...] I’ll say teach me place value using this number. And they will say ‘hey, here’s [...] Mickey the math expert and kids today we are learning...’ they will write me a creative [entry], something that can be published. I usually say [the writing is] for a younger kid to understand so there’s got to be pictures, there’s got to be words and it’s creative way of explaining [...] [1. Highlight for understanding; 2. Make a plan, 3. Carry out the plan, 4. Check work] math journal is teaching.

Within this example, it is clear that Angelina puts the focus of assessment on the students’ strengths. She pushes the students to make sure they are tapping in to multiple senses to express their knowledge.

Sara further commented:

[Arts integration] could be something that you do for fun to supplement [math], but I think [...] [t]he students wouldn’t necessarily internalize the concept as well if you are just teaching them only through the arts as opposed to having specific math lessons and then integrating it to show what they know [...]”

She continued:

[The second time I taught the patterning unit [the students] needed to know the difference between a growing and repeating pattern [...]. There were two different dances that we did. One was a growing patterning
Integrating the Arts in Mathematics Teaching

which was the Cha Cha slide so one step, the one step plus another step, then one step plus another step plus another step so then following that so [...] I guess through their coordination and through watching them dance that I knew that they got it, that they understood it.

Sara clearly expresses a belief that a single method of teaching is not sufficient for student success. She shows that the point she truly understood that her students had solidified their knowledge of patterning was through their dance performance. Without this performance, she may have missed some students demonstrating their knowledge of patterning. For Sara, arts integration is a means to provide breadth and depth to a math unit and a way to reach every student and capitalize on their specific way of learning and expressing knowledge.

Multiple Intelligences and the Foundation of Differentiated Instruction

Because the arts are specialized areas that tap into nearly all of the multiple intelligences, it became clear through the interviews that arts integration in the mathematics classroom makes the focus of learning on the students. That is, the learning becomes centered on student strengths and applies the knowledge in multiple ways to ensure that each student is able to learn and express in a way that is tailored to their specific strengths in learning. Key to differentiated instruction is embedding and using teaching strategies that appeal to various multiple intelligences. Planning with multiple intelligences in mind, teachers are able to differentiate the process, product, and content according to student interest.

Because differentiation is such an important aspect of contemporary teaching and learning practices it was an important finding that differentiation was seen as such
Integrating the Arts in Mathematics Teaching

a key result when creating an integrated arts and math lesson or unit. To support this,

Angelina commented:

So, not all kids are comfortable getting up or being in front. That isn’t necessarily the arts even though I am a drama specialist it’s ah you have to differentiate so that the child that learns through the drawing needs to be given a drawing opportunity. The child who is musically inclined that needs to be able to sit at a piano and write a song about that theme. Those that want to get up [move around to express their knowledge can create a dance to show their understanding]. Other times it is important to group them by the different learning styles. [...] If I were to create a group I would try a [student who has a] strength in visual [arts], a [student who has a] strength in drama, a [student who has a] strength in music, [...] so they can build on each other’s skills. Not everybody has to be a look at me look at me kid through the arts [...] there’s a subtle way to approach the learning but I think basically 100% [the arts] differentiate the learning.

For Angelina, it only makes sense to use the arts to differentiate. In this way you are not only making room for all of your students to express their learning, you are doing so in a way that taps in to multiple curriculum areas.

**Increased Student Engagement + Flexibility = Increased Opportunity for Learning**

Throughout the interviews, each of the participants expressed that arts integration provides additional opportunities for learning in the classroom. They expressed that student engagement rose with the integration and as a result the opportunities to see math in the classroom expanded. The opportunities for learning are increased because there becomes increased teaching time for math in the classroom.

One of the most daunting tasks as a teacher is to create a classroom that engages students in a fun and interactive way while ensuring all the necessary curriculum is covered. The participants suggested that arts integration is an excellent tool to engage students. Students are able to have fun and become immersed in their
Integrating the Arts in Mathematics Teaching

learning away from their traditional textbook and being held down to a chair and desk with a pencil and paper task. When explaining her lesson on perimeter, Angelina commented:

[The students] are out of their seats. It’s not just about giving them a definition of perimeter and then assigning the textbook page. They were all engaged because they are watching the model and then the old man chasing her [...] and it became this funny scene. [The old man would say] ‘oh slow down sweetie’, [...] and then the police officer came in and they did the scene, scene in drama, using perimeter, only the perimeter of the stage.

The students in this example were able to see perimeter come to life. They came to understand that regardless of speed, perimeter stays the same. Even though the model was walking faster than the old man, the perimeter was always constant. For the students in Angelina’s class, the idea of perimeter was given context and they saw math being used in a real life situation. From this, it became evident that students feel freer to express their understanding and are less tied down by the traditional conceptions of what their teacher is looking for:

I [...] see that it is beneficial because the kids are free, they are free to express themselves. [I]t is just more relaxed. [...] They see it as art is fun, they don’t see it as like Mrs. [Sara] is looking to see that I spelled the word correctly or I put the number correctly, they just feel that it is a time to express [...] their interpretation of what it is that we are doing.

Students are engaged in the math because they are moving and are exposed to alternative ways of thinking about and seeing numbers and mathematical concepts. Because the students are starting to see numbers in a more fun and interactive way with relation to the arts, they begin to seek out ways to make cross-curricular
Integrating the Arts in Mathematics Teaching

connections and proving their ability to be flexible thinkers when it comes to math. In her interview, Julia suggested:

Students begin to view math from a different perspective. They are enthusiastic about learning through the arts, and even when there is no arts integration they often looks for ways to learn a new concept through a mind map, song or action dance. Once you model [arts integration] for students, they will begin to integrate their own learning to help them better understand and like math.

Further, these students’ boundaries in math are being pushed to make them truly think about their learning. This is beneficial for students who excel in math and for students who may also be struggling learners. Because all students are engaged in their task using creativity and an alternative way of thinking and knowing, they are constantly being pushed to expand their understanding and further their thinking. For example:

[T]here are more opportunities for learning [through arts integration] and I think children that struggle with computations and [...] think I’m no good [...] those that struggle [...] can do it creatively in a math journal. [The journal] actually will boost their mark because they are approaching [math] differently. It also works for those math geniuses that are doing it in their head [...] because having them express it through language can sometimes take that 100% down to a 95% [...] because they don’t want to explain it they don’t want to take time to explain it [...] I found at least the written journals and the creativity will help those struggle who get it back and they get a 3 or a 3+ and are like, oh, I do get it as opposed to the quiz where they got 68.
Integrating the Arts in Mathematics Teaching

Sample Lessons

Grade 2 Fractions & Note Values

Expectations

Music:
C1. Creating and Performing: apply the creative process to create and perform music for a variety of purposes, using the elements and techniques of music.
   C1.5 Use symbols to represent sounds and sounds to represent musical symbols

C2. Apply the critical analysis process to communicate feelings, ideas, and understandings in response to a variety of music and musical experiences
   C2.3 Identify and give examples of their strengths and areas for growth as musical performers, creators, interpreters, and audience members

Math:
Read, represent, compare, and order whole numbers to 100, and use concrete materials to represent fractions and money amount to 100 cents
   Determine through investigations using concrete materials, the relationship between the number of fractional parts of a whole and the size of fractional parts
   Regroup fractional parts into wholes, using concrete materials

Compare fractions using concrete materials, without standard fractional notation

Minds On

* It is expected that students will have a general understanding of music notation before this lesson. The students will have had some exposure allowing them some familiarity in identifying whole, half, quarter, and eighth notes.
* It is also important that students have had exposure to fractions. The students will have experimented with looking at parts of a whole and using symbols to represent different parts of the fraction. The music notes will serve as an additional symbol for students to explore fractions.
* This lesson will be used to allow students to solidify their knowledge of notational values and the relationships between fractions using symbols and a whole. This lesson is not intended to introduce fractions, music notation, rhythm, dynamics, or tempo. The students will already have an understanding of using symbols to represent fractions and they will understand that music notes are another symbol that can be used to explain their mathematical knowledge of fractions as well as their ability to compose using a specific time signature and perform various rhythms for a specific audience and to convey a particular emotion.
Part 1
- As the students are entering the classroom music will be playing in the background. The students will be given a question written across the board: How does this music make you feel? What about this song is making you feel this way?
- Once the students have had a chance to think about the music they are listening to the students will be asked to “Think, Pair, Share” how the music made them feel.
- Once the students have shared, the music will be played again. This time the students will be asked to tap their foot to the music. I would like the students to try to focus on their own body and listening to the music without paying attention to the other students.
- After the students have had a chance to feel the music they will be asked to “Think, Pair, Share” again. This time they will be asked to think about the tapping of their foot. What did you notice about the tapping of your foot (how fast, how slow, how loud, how soft) that also showed how you were feeling when you heard the music?
- Students will return to the whole group on the carpet and will reflect on this. The teacher will play a few more examples of music and as a class look at the emotions that arise and demonstrate how the students may use body percussion (a term the students are already familiar with) to tap their foot to the beat of the song.

Part 2
- The students will be asked to look at the chart called “Magic Feet Move to the Beat”
- They will practice how each type of note sounds when using their feet. They will mimic this with clapping their hands, snapping, tapping their hands on their legs.
- The students will be spread out around the room and will be given different combinations of notes and will need to tap to the beat. Every few minutes they will have a chance to discuss with a partner the sounds they are hearing, how it makes them feel, what they feel in their body (heart beat) when they are tapping to the rhythms of the different note values.
- In this time the teacher will also take the time to talk about the note values in relation to a whole bar or a whole note. The students will understand 4/4 time and will know that one whole note takes up an entire bar of rhythm in 4/4 time. The whole note will be their reference in the action part of the lesson. As a class they will look at different combination of notes and will use the “Magic Feet
Integrating the Arts in Mathematics Teaching

Move to the Beat” to make different rhythms that equal 4 full beats or a full bar of music in 4/4 time

**Action**

*During this part of the lesson the students will be using a caterpillar model to create a bar of rhythm in 4/4 time. They will be using their knowledge from previous lessons and the minds on activities to create their rhythm.

- Students will gather again on the carpet with the teacher. The teacher will show them the caterpillar bar (The caterpillar is used to represent a bar of rhythm. The head of the caterpillar has the time signature. The caterpillar has 4 body parts. Each part represents one beat of music in 4/4 time or one quarter note. If there is a half note in the bar the note will be written on one circle and the circle immediately following will be blank to show that the beat takes up two spots for two beats (shown in example). A quarter note takes the space of one circle and two eighth notes are grouped together to occupy the space of one circle. The caterpillar is used because it allows the students a visual representation of the space that is being taken up by each note in a bar of rhythm. This is important from the mathematics perspective because the students are responsible for identifying fractions in relation to a whole and the amount of space they occupy).

- The teacher will use a think aloud to show the students how to use circles of the caterpillar’s body to create a full bar of rhythm. The teacher will show the examples to the class and then go through the process of creating the rhythm explicitly stating their thought process to the class.

- The teacher will next practice their piece first by clapping the rhythm making sure they are happy with the way it sounds.

- The teacher will then pick an emotion and experiment with different body percussion to make certain sounds. Each time the teacher experiments with a new sound they will explain what emotion they think that sound is conveying.

- The teacher and the students will talk about what was successful and what was not successful in the teacher’s performance. Together they will develop the success criteria that will be used in both the peer assessment and the final teacher assessment.

- After the students have watched the teacher create their piece the students will return to their desk. Each student will be given a variety of circles (one head with a time signature and multiple body circles. Some of the body circles will have half notes, quarter notes, eighth notes, and blank circles). They will have the opportunity to try different combinations and clap them out. Once they
have decided on a combination of notes they will glue the pieces together so they create a caterpillar.

- The students will be asked to brainstorm ideas on a piece of blank paper. They will show the different combinations they tried and use pictures, symbols, numbers and words to track their thinking and explain how each combination equals one whole. This will be used by the teacher, in addition to the presentation, to track the students thinking and understanding of music notes in relation to fractions.

- As the students finish their bar they will find a partner who has also completed their bar of rhythm (this may change depending on the accommodations or modifications necessary as mentioned in the accommodation/modification section of the lesson plan).

- The students will practice their rhythms and teach them to one another. The students will also be expected to explain their rhythm to their partner. In this explanation the student will need to explain why they chose their notes, how these notes work together to make a full bar of music, how much space each of the notes takes in the bar and what this tells them about the note and the part it plays when working with the other notes to create a full bar of music.

- In the first part of the lesson the students will be asked to:
  1. Brainstorm different rhythmic combinations. Create a brainstorming sheet on a blank piece of paper to show how the different combinations of notes equal one whole bar using both numbers, pictures, and symbols.
  2. Create a bar of rhythm in 4/4 time using a variety of notes (at least 2 different types)
  3. Practice the rhythm using body percussion
  4. Find a partner and teach one another your rhythms
  5. Combine the rhythms to create two full bars of 4/4 time
  6. Choose an emotion with your partner and begin to brainstorm ways to convey that emotion using various body percussion

- The students will come back together with their partners and finalize their rhythms.

- The students will find another set of partners and will come together and perform their combined rhythms. The students will use the peer assessment checklist to provide feedback to their peers.

- Each partner group will listen to the other set of partners perform and discuss their rhythms. They will talk about their emotion, the way they used different sounds to convey their emotion and the way they used different notes to create a whole bar.
Integrating the Arts in Mathematics Teaching

- Once feedback is given the students will return to just their pairs and continue to finalize their rhythms. They will use the feedback to continue to improve their piece and make sure they are ready to perform for the class.
- The teacher will be walking around making anecdotal notes of student conversations about their compositions.
- In the second part of the lesson the students will be asked to:
  1. Practice your rhythm and finalize the types of body percussion that will be used to convey your emotion
  2. Find another pair and perform your rhythm
  3. Use the peer evaluation checklist to help your peers finalize their rhythm. Provide feedback to your peers.
  4. Finalize your rhythm using the feedback from your peers to make sure you are correctly representing the notes in a bar of rhythm and can explain their relation to the whole note or bar. Also, make sure your body percussion, tempo, and dynamics properly show your emotion

Consolidation

- Once the students have finalized their compositions they will come together as a whole class perform, explain their composition and to listen to each other and provide feedback in the form of 2 stars and a wish.
- During the presentation the teacher will be completing a checklist for the students as an assessment for learning. As part of the checklist and the student reflections the audience will provide the groups with two stars and a wish.
- The students will need to identify why they left spaces after half notes, why eighth notes need to share a circle and why quarter notes are given one circle. This will show their ability to use music notes as a symbol to represent fractions of a whole.

This lesson explicitly allows teachers to give students a concrete example of fractions in their every day lives. Teaching fractions through music notation also provides teachers with an alternative to traditional manipulatives commonly used in the classroom.
Grade 3 Patterning & Music Performance

* Contributed by Sara Varga

Expectations

Music:
**C1. Creating and Performing**
C1.2: Apply the elements of music when singing, playing an instrument, and moving
C1.3: Create compositions for a specific purpose and a familiar audience
C1.5: Demonstrate an understanding of standard and non-traditional musical notation

**C2. Reflecting, Responding, and Analyzing**
C2.3: Identify and give examples to their strengths and areas for growth as musical performers, creators, interpreters, and audience members

Math

**Patterning and Algebra**

*Overall Expectations:*
- Describe, extend, and create a variety of numeric patterns and geometric patterns

*Specific Expectations:*
- Identify, extend, and create a repeating pattern involving two attributes (e.g. size, colour, orientation, number) using a variety of tools (e.g. pattern blocks, attribute blocks, drawings)

Demonstrate, through investigation, an understanding that a pattern results from repeating an action (e.g., clapping, taking a step forward every second), repeating an operation (e.g., addition, subtraction), using a transformation (e.g., slide, flip, turn) or making some other repeated change to an attribute (e.g., colour, orientation)

Part 1

*Prior to this lesson, students have already had lessons in patterning and algebra and are already familiar with the various terms that are associated with patterning and what makes a pattern a pattern (different attributes, how they extend, and repeat etc).

*The students have already had experience with auxiliary percussion, body percussion, and boomwhackers as well as the fundamental concepts that will be incorporated in their performance (dynamics and other expressive controls and timbre)

- Play the Cha-Cha Slide by Mr. C as the students start coming into the classroom
Integrating the Arts in Mathematics Teaching

- What do you notice about this song? -- E.g., how there is an extension of patterns -- one step, then two step, using body percussion to produce the music
- What makes this song a pattern?
- Develop a K/W/L chart with the students to rediscover what we have learned in patterning and algebra as well as producing music
- Show the students my own visual pattern
  - What do you notice about my pattern? -- E.g., the different attributes and how it could be extended
- I begin to use the instruments/body percussion to illustrate my visual pattern
  - Why do you think I used the instruments the way I did -- E.g., I put a large circle to illustrate how loud and the quality I had produced for my visual pattern (dynamics of the instrument and timbre) and I used a small circle beside it to illustrate that I would play the instrument softly (the circle represents the type of instrument and the size of it represents how loudly/softly I play it)
- Have the instructions of what the students are supposed to be doing for this assignment/performance
- Share the learning goals with the students
  - In groups of 4 you will be creating a pattern with at least two different attributes
  - Each attribute will determine which instrument will be used and how it will be used (E.g., the circle represents a boomwhacker: a big circle represents me playing the boomwhacker loudly, a small circle represents me playing the boomwhacker softly)
  - Shows how music can get louder and softer
  - Leave room for an extension for your classmates to determine what will be next

Part 2

- Split the class into groups of four (groups are determined by having a variety of strengths -- some will be stronger in math, while others will be stronger in music this way students will be able to contribute their strengths to the group)
- Designate certain areas in the classroom for each group to go to so they have their own room to explore
- The instruments will be on a few different desks for the students to go and experiment with the sounds before determining which ones they want to use (the distribution of the instruments will help avoid clusters of students and confrontation)
Integrating the Arts in Mathematics Teaching

- They will write down their patterns and leave room for classmates to determine its extension
- Once they determined what they want their pattern to look like, they will go back to the instrument table to choose which ones they want to use -- Unifix cubes will be provided for those kinesthetic learners
- They will be given the self-assessment to determine if they have covered what they needed before their performance

Part 3

- We will revisit the learning goals before the presentation
- Each group will perform their visual patterns
- At the end of their performance, they will explain why they made their pattern the way they did and why they chose the instrument they did and how they played it
- The rest of the class will be asked to fill in the blanks to extend the group’s pattern
- I will have a check-list prepared that is similar to that of the student self-assessment check-list to determine if they met all the requirements and learning goals we had determined previously
- Revisit the learning goals and have a class discussion if we think that we have covered everything that was determined on the list

This lesson can be expanded to include visual arts and mathematics including shapes and Picasso art in relation to patterning. *see lesson below.
Integrating the Arts in Mathematics Teaching

Grades 1-3 Patterning, Music & Visual Arts Lesson

Expectations

Math Grade 1
- Identify, describe, extend, and create repeating patterns
- Create a repeating pattern involving one attribute
- Represent a given repeating pattern in a variety of ways

Math Grade 2
- Identify, describe, extend, and create repeating patterns, growing patterns, and shrinking patterns
- Identify repeating, growing, and shrinking patterns found in real-life contexts (e.g., a geometric pattern on wallpaper, a rhythm pattern in music, a number pattern when counting dimes);
- Represent a given growing or shrinking pattern in a variety of ways
- Create growing or shrinking patterns
- Create a repeating pattern by combining two attributes

Math Grade 3
- Describe, extend, and create a variety of numeric patterns and geometric patterns;
- Identify, extend, and create a repeating pattern involving two attributes (e.g., size, colour, orientation, number), using a variety of tools (e.g., pattern blocks, attribute blocks, drawings)

Music
- C1. Creating and Performing: apply the creative process (see pages 19–22) to create and perform music for a variety of purposes, using the elements and techniques of music;

Visual Art
- D1. Creating and Presenting: apply the creative process (see pages 19–22) to produce a variety of two- and three-dimensional art works, using elements, principles, and techniques of visual arts to communicate feelings, ideas, and understandings;

Background Information

- This lesson is based on the understanding that students will have some prior knowledge on patterning
- The lesson is framed in a way that it can be used for students in grades 1-3 and differentiated within each of the grades – the purpose of the lesson is to have the students create a piece of art that expresses their understanding of patterning

**If technology is available in the classroom this entire activity can be adapted to be used on iPads using a paint application. The artwork may be
Integrating the Arts in Mathematics Teaching

more difficult to create for the students but will give them the chance to engage with technology, visual art, and patterning

Part 1

- Students will be presented with a question on the board: how many patterns can you see in the class?
- They will be in partners or small groups and will be given a worksheet where they can identify the pattern and draw the core of the pattern
  - This is allow the teacher to find out how much the students know about patterning through engagement in student discussions
- For students who finish early, ask them to come to the carpet and discuss with a partner why they think it is important for patterns to be in our everyday lives.
- Once the students have finished identifying patterns they will return to the carpet to discuss their findings
- Before the students begin to discuss they will be read the book “Pattern Fish”
- The class will have a discussion to unfold patterning in a brief or more in-depth review depending on the knowledge the students are displaying
- The discussion can be framed around the following questions:
  - What patterns could you find around the room?
  - How do we know this is a pattern?
  - What makes a pattern a pattern? (A core or a part that repeats)
  - What things can change in a pattern? (Attributes: size, shape, colour, thickness)
- Use a think, pair, share to have the students unpack their findings – they will be able to discuss with a partner to really cement their understanding of a pattern (Their knowledge will depend on the grade and whether patterning has been covered but each student will have some knowledge of patterning and will be able to identify that a pattern has a core that repeats

Part 2

- The students will be given a piece of blank paper. As a class they will fold their paper in half, in half again, and in half again
- They will open up their paper and make sure they can identify where the paper has been folded
- Each student will identify a place on the page where they will draw the first letter of their first name. For lower primary, this process will be modeled by the teacher to the whole group. For students in grade 3 the teacher can show the students in a demonstration but do not have to strictly model and make sure students are following the steps carefully. If upper primary, the teacher can walk around the class to make sure the students are writing their initial on the page – they can choose to draw the initial any way they would like (cursive, bubble, regular print)
Integrating the Arts in Mathematics Teaching

- Once the students have drawn the initial they will begin creating their pattern. ON a separate sheet of paper the students will create two patterns. The number of attributes and complexity of the pattern will depend on the grade and the individual students. This is where the activity can also be differentiated because the students can choose their level of complexity. Students who are more comfortable with patterning will have the opportunity to create more complex patterns.
- Once the students have drafted their patterns they will begin to transfer them onto the paper. Each space that was created for the folds will provide the line where the pattern will be drawn. The students will alternate patterns in the spaces. So, pattern 1 will go in space 1, pattern 2 will go in space 2, pattern 1 will go in space 3 and pattern 2 will go in space 4.
- The students will draw their patterns and colour their art. They should be encouraged to colour the background of the picture and the pattern to make it as artistic as they can.
  - Students who finish early will be asked to add sounds to their patterns. They can practice the pattern using clapping, snapping and stomping. Students will be able to do this with a partner that is also finished their work.

Part 3

- once the students have had the opportunity to create their art they will be given the opportunity to meet on the carpet and share their work
- Give the students an opportunity to ask questions about each other’s art and the patterns they created. This will give the students the chance to tap into the understanding of their peers once they have had the opportunity to engage with creating patterns in an alternative way.
- Students who had time for the extension activity will be able to share the sounds they added to their patterns.
- As a class we will create a pattern and add sounds for each symbol. We will practice the rhythm with elbow partners and then come back and perform as a whole class. This will give the students a chance to extend their knowledge and also an opportunity to be active in the classroom (this could be a way to extend DPA into the lesson or into the school day)
Integrating the Arts in Mathematics Teaching

Pattern Art

Name: ___________________

The patterns I saw were...

My patterns are...

56
Chapter 5  
Discussion  

Introduction  

This research study has provided information in the area of arts integration in the mathematics classroom that has reaffirmed prior research and has provided extensions of knowledge, examples of best practices, and tips for teachers wishing to incorporate the arts in their mathematics classroom. This final chapter will combine prior research with the findings from this particular research study to provide implications for the teaching profession.

From Theory to Practice  

Initially when undertaking this research study, I was concerned that the research was theoretical and provided much proof for the usefulness of arts integration but did not provide significant practical information. I thought that it might be difficult to find educators who supported the theoretical research and took this knowledge and made it their practice. What was surprising, after completing the interviews, was how well the literature and the participants responses worked together to create a succinct picture of the benefits and practicality of arts integration. Many of the ideas expressed by the participants closely followed the theories that supported arts integration although they may not have necessarily spoke directly to a specific theory. For the participants, arts integration is part of their philosophy and it just so happens to be supported by the research.

Why Integrate the Arts in Mathematics Teaching?  

One of the most prominent commonalities between the literature and the participant responses is that the arts are embedded in all aspects of life and are
what make each individual a human being filled with feeling and emotion. Eric Jensen suggests that arts have a specific role in human life and development. For Jensen, the arts are what make us most human (Jensen, 2001). All of the participants commented on the embodied nature of the arts and how it allowed students to fully engage with the material they were learning. The participants clearly stated that in their experience they were able to see in action what Eric Jensen is suggesting. The students understand and apply their mathematical knowledge when they can delve deep into themselves to feel the material at their very core.

Further, the participants and literature complimented one another in their idea that the arts is a way for teachers to reach all students in the mathematics classroom. Cornett and Smithrim (2000) suggest that teaching through the arts allows struggling students who are having difficulties connecting to the material they are being taught find ways to interpret and understand the material. Angelina spoke specifically to this idea when she spoke about the individuality learning through the arts provides. She commented on the ability of her students to use their skills and talents to present their mathematical understandings. Every individual is able to connect to the arts in some form whether it is the type of dance or music they enjoy. The connection that all individuals have to the arts allows every student to transfer this connection to their learning in mathematics making this learning concrete and transferable and meaningful to various facets of their lives.

*Multiple Intelligences*

The arts make learning physical and embodied. This very point is a distinct commonality between the theoretical research and the practical implementation of
Integrating the Arts in Mathematics Teaching

arts integration addressed by the participants. The arts allow students the opportunity to understand mathematics from multiple perspectives. As the research suggests the arts connect to each of the multiple intelligences and provides teachers with the opportunity to differentiate instruction in the math classroom. The participants supported the claims made in the research suggesting that arts integration gives students opportunities to express their knowledge in multiple forms. Consequently, students who struggle are given more points of connection to the material and students who excel with “traditional” classroom approaches are provided with a challenge to expand their ways of thinking when they are asked to connect their mathematical understandings with their knowledge of the arts. As the participants and the research suggests, students are able to think flexibly about mathematics and are able to see the connections between what they are learning in the classroom and what is happening in their everyday lives.

Holistic Education

The arts requires teachers to approach the curriculum from a holistic perspective and allows these teachers to teach to the whole student. As stated above, the arts are a way to reach all students and teach to their multiple ways of knowing. The literature on multiple intelligences and the study conducted by Min (2013) substantiate the participants understanding of, and perspective on, arts integration in the mathematics classroom. The participants suggested that there is a need to approach arts integration with both mathematics and the arts as equally important when planning. They are to be understood as a whole picture of education and not dichotomous entities. Win (2013) suggests a similar idea where
Integrating the Arts in Mathematics Teaching

students can only be taught from a holistic perspective when the division between subjects is removed. Additionally, similar to the above discussion of multiple intelligences, arts integration allows for the whole student to be taught. Readdressing Jensen, the arts are important in an individual’s ability to be fully human, and thus, it is important for teachers to use the arts in their teaching if they have the expectation of teaching students holistically.

How to Integrate the Arts

How teachers can integrate the arts in the mathematics classroom was not a dominant finding in the literature reviewed. The research focused largely on the implication of arts integration. The findings from the participant responses extends on the theoretical knowledge and moves us towards recommendations for practice. The participants suggest that successful arts integration begins with the teacher. The way the teacher approaches the curriculum, using the lens of the arts, impacts the ways students perceive and are able to think about the arts in mathematics and mathematics in the arts. We can infer from the literature on multiple intelligences and differentiation that the way the teacher approaches his/her classroom curriculum is the root of differentiation and teaching to multiple intelligences. Combining what the participants suggested and what is found in research that supports integration we can see that teachers need to begin their integration with an open mind and willingness to bring the arts alive in the mathematics classroom.

One theme that emerged in the interviews that did not emerge from the literature was that the teacher approach matters when integrating the arts in the mathematics classroom. Much of the research focuses on student responses to arts
Integrating the Arts in Mathematics Teaching

and the way arts integration supports theories like multiple intelligences. All of the participants suggested that the approach taken by the teacher is a significant factor in a successfully planned and implemented arts integrated approach to math.

Implications/Recommendations

This research provides further support for the integration of the arts in the mathematics classroom and perhaps across multiple subject areas. Student engagement and participation is increased as a result of integration, therefore, making arts integration seem like a positive addition to any classroom. As a result of the literature and complementary findings through this research study it is recommended that educators look to arts integration when attempting to differentiate student instruction. The arts seem to be a source of positive and engaging learning for students and thus, it is important for educators to attempt to bring in the arts to address the multiple ways of knowing that are present in today's classrooms.

The arts can be viewed as highly specialized subject areas and making successful integration seem unattainable for those untrained in specific areas of the arts. In fact, what has been suggested through this research is that arts integration can be possible for any educator wishing to learn to have fun and incorporate many ways of thinking and representing knowledge in the classroom. This study has led to the recommendation that educators, and perhaps schools more generally, look at arts specific training or the use of arts specialists in the classroom to begin the process of arts integration in mathematics. For pre-service teachers, arts integration should become a larger component of their training. Currently, the arts are given
Integrating the Arts in Mathematics Teaching

only a small amount of time in pre-service teacher education. Based on the findings of this research study, it is clear that students benefit from arts integration and therefore arts courses that focuses on education should be given more time with experienced professors or arts integration should become part of the syllabus for the classes in all of the core subject areas.

A list of recommended practices can be derived from this research:

• Use student expertise when integrating the arts; some students may have a significant knowledge base in a particular area of the arts and asking for their assistance allows them to be leaders and agents in their knowledge
• Tap into the skills and resources from colleagues in your school community and those found online or from your specific Board and the greater arts community
• Think of arts integration as a way to teach holistically and use students multiple intelligences
• Think of arts integration as allowing students to tap into their multiple ways of knowing
• Try not to see one subject area as more important than the other. Think about the subject areas equally and use them to work with one another to create a whole picture for the students instead of two distinct subjects attempting to work together.

Limitations

The selection of participants posed the largest limitation to the study. Three of the four participants had significant backgrounds in the arts. This is problematic because their view of integration may be different from those who do not have
Integrating the Arts in Mathematics Teaching

significant knowledge of, or training in, a specific area of the arts. Future research should look to include perspectives of individuals with varying degrees of involvement in the arts over their lifetime to truly unearth the possibilities that are available through arts integration and further strategies and tools to help with the implementation of a successful arts integrated approach to the mathematics classroom.

Further Study

This study connected research and practice well. The findings suggest further support for arts integration and arts integration specifically in the mathematics classroom. Future research should focus on the integration of the arts specifically in the mathematics classroom. Because much of the research focuses on arts integration in literacy, it is important to begin to expand the research on arts integration in other subject areas. From this research, there should be a focus on strategies, tools, and further examples to assist teachers wishing to purpose arts integration in the mathematics classroom.

Further, I believe that it is important to look specifically at the teacher approach when integrating the arts across all subject areas. Because teachers are the makers of the learning environment, it is essential to recognize the importance of their approach to the curriculum and consequently student education. Further research should delve more deeply into the perspective, philosophies, and pedagogies of teachers who successfully integrate the arts in the mathematics classroom, or perhaps integrate the arts more generally to allow for a better
Integrating the Arts in Mathematics Teaching

understanding of the way in which successful arts integration begins with the teacher.

Conclusions

Mathematics education is a key focus in Ontario education at this time. Finding a way to make mathematics appealing to all students is an important step for teachers. Integrating the arts in the mathematics classroom is an incredible means to engage all students and ensure they are connecting with the mathematics curriculum. Teachers must be sure to look at the curriculum holistically and appreciate the importance of both mathematics and the arts. It is important to see our students as whole individuals who have multiple ways of thinking, knowing, and representing information. The literature and the participants in this study have identified the arts as a clear means to provide an approach to mathematics education that best meets the needs of students in the 21st century classroom. This study concludes with the suggestion that pre-service teachers should be provided with a more in depth education on arts integration that presents them with the tools to create a coherent arts integrated approach to the mathematics curriculum across age groups in elementary school. Practicing teachers should take the time to educate themselves on the importance of arts education and practice integration across the curriculum, but specifically in mathematics, to provide their students with multiple opportunities to express their knowledge. Though uncertainties in arts education will continue to make educators wary of its implementation, the benefits afforded to arts integration through this research student are a testament to integrations successes and their importance in mathematics education.
Integrating the Arts in Mathematics Teaching

Appendix A

Date:

Dear ______________________,

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

The purpose of this requirement is to allow us to become familiar with a variety of ways to do research. My data collection consists of a 45 minute interview that will be audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient to you, outside of school time.

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

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

Yours sincerely,

Researcher Name: Dakota Baird
Phone Number, Email: (416) 720 0290, dakota.baird@mail.utoronto.ca

Instructor’s Name:
Phone Number:

Consent Form

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

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

Signature:

Name: (printed) __________________________________________

Date: ___________________________
Integrating the Arts in Mathematics Teaching

Appendix B: Sample Interview Questions

1. Can you tell me a bit about how long you have been a teacher, and a bit about the context of the school you are currently working in?

2. What is your background in the arts? How did you develop an interest in the arts?

3. Do you integrate the arts across all subject areas? Which do you feel more and less comfortable with?

4. What opportunity do you see for integrating the arts in mathematics?

5. What instructional strategies do you use to weave mathematics together with one (or more) of dance, drama, music, or visual arts to create a comprehensive math program for students?

6. What steps do you take when creating an arts based math lesson or unit?
   a. What do you use to structure your integrated math lessons? Do you start with an arts based or mathematical concept?
   b. Why do you approach planning from this lens?

7. Can you give me some examples of how you have integrated the arts with mathematics?
   a. What were your learning goals? What did the lesson involve? How did you evaluate the lesson?

8. What resources do you use to teach math through the arts? (e.g. resources developed by particular organizations or associations, books, music, websites, manipulatives etc.)
9. In your opinion, what skill sets and knowledge base is required to design an arts based curriculum in math?

10. How do your students respond to your arts based approach to teaching mathematics?
   
   a. What kinds of outcomes have you observed?

11. What recommendations would you give teachers who are interested in teaching mathematics through the arts?

12. Have you faced opposition from colleagues, admin, or parents with regard to your approach to teaching mathematics through the arts? If yes, what were the causes of opposition and how did you respond?
Integrating the Arts in Mathematics Teaching

Appendix C: Student Work Samples
Integrating the Arts in Mathematics Teaching

References


Integrating the Arts in Mathematics Teaching


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