THE IMPACT OF NON-BAND MUSIC PARTICIPATION ON THE ACADEMIC ACHIEVEMENT OF 6TH GRADE MATHEMATICS STUDENTS

by

Sherica Denise Jones-Lewis

Liberty University

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Of the Requirements for the EDUC 990 Course

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Abstract

It is hypothesized that participation in non-band music has a positive impact on mathematics achievement. Maslow's Hierarchy of Needs, the theory of self-determination, multiple intelligence theory, and brain research provide a theoretical foundation in support of this conjecture. This causal comparative study seeks to address three questions related to the hypothesis: a) is there a difference between the academic achievement of 6^{th} grade mathematics students based on non-band music participation status; b) is there a difference between the academic achievement of 6^{th} grade males based on non-band music participation; and c) is there a difference between the academic achievement of 6^{th} grade females based on non-band music participation? In order to conduct the study, the researcher was granted access to digital spreadsheets of 6^{th} grade scores, from the 2013-2014 administration of the Northwest Education Association's Measures of Academic Progress assessment. After sorting scores for students who participated in instrumental music class (or band), scores were separated into two groups, scores for students who participated in non-band music class, and scores for students who did not. The data for each group was analyzed by: constructing frequency polygons, developing sets of descriptive statistics, and examining the means and standard deviations. This process was repeated to examine scores for each set of students. Subsequently, *Mann-Whitney U Test*s were used to compare medians. The research found that participation in non-band music class had a positive impact of mathematics achievement.

Keywords: music, mathematics, engagement, self-determination theory, multiple intelligence theory, Maslow's hierarchy of needs, brain research

DEDICATION

This manuscript is dedicated to my three amazing sons and my husband, Charles. Iceysis, Che', and Langston, I want to thank you for the sacrifices that you made in order that my dream could become a reality. Charles, you are a blessing, and I thank God for you. I also want to thank the countless others who were there when I needed them throughout the dissertation process. Truly, I can say, "I can do all things through Christ who strengthens me" (Phillipans 4:13).

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CHAPTER ONE – INTRODUCTION

Music programs across the country are being cut in order to allocate more funds for reading and mathematics instruction (Henwood and Featherstone, 2013). However, students in the United States are not making progress in the area of mathematics, when compared to students in other developed nations (Wagner, 2008). This study seeks to investigate the impact of non-band music participation on the academic achievement of 6th grade students. The findings will attempt to contribute to the body of research used in making local, state, and national decisions regarding the inclusion of music instruction at the middle school level. While the intersection of music and mathematics is not a new area of study, the focus on non-band music participation as opposed to band serves to differentiate this research from that of others (Catterall, 2011; National Association for Music Education, 2007). Additionally, the use of data from 6th grade, middle-school students who participated in non-band music or no formal music separates this study from that of the impact of instrumental music participation at the high school level and impact of non-band music participation at the elementary school level. Chapter one provides a brief overview including: an explanation of background; specification of both problem and purpose; exploration of potential research significance; and a brief synopsis of methodology. The chapter concludes by identifying variables, clearly outlining definitions, and exploring limitations and delimitations of the proposed research.

Background

The Elementary and Secondary Education Act (ESEA) of 2010 is often referred to as No Child Left Behind (NCLB; U.S. Department of Education [USDOE], 2010). This law asserts that all students attending public elementary and secondary schools must take standardized tests in order to meet accountability measures in the core content areas of reading, mathematics, social studies, and science. While the ESEA legislation recognizes the arts as a core content area, it does not require that schools meet accountability measures in this field of study. The impact of the ambiguous inclusion of the arts in the ESEA legislation, combined with need for budgetary restraint, has resulted in the curtailment or cessation of music programs across the country (Major, 2013).

Even the best schools in the United States are failing to teach students what they need to know to be successful in the 21st century (Wagner, 2008). However, many teachers and other instructional personnel are reluctant to move away from outdated teaching methods, even as research reveals that meaningful learning is not taking place, causing the United States to fall further behind other developed nations (Cole, Bergin, & Whitaker, 2008). Reading and mathematics assessments have come to determine the fate of school divisions across the country. Thus, many classrooms have turned into mechanized institutions, aimed at having students make the grade, resulting in student boredom (Cole, Bergin, & Whitaker, 2008).

The school experience morphs as students progress through the educational system, in order to prepare them for standardized testing (Sparrow & Hurst, 2010). These changes become more and more evident as the stakes of tests rise from level to level. When transitioning from elementary to middle school, students face a variety of changes as the workload becomes heavier, tasks grow more difficult, the grading process tightens, and instruction becomes less personalized. This is also the case when students move from middle to high school (Jang, 2008). This multitude of challenges often leads to a decline in student motivation and, subsequently, achievement (Cole, Bergin, & Whittaker, 2008; Dogan-Temur, 2007; Jang, 2008; Zepke & Leach, 2007). This problem is exacerbated when unmotivated students attend classes where they are bored and feel disjointed from what is happening around them (Jang, 2008; Zepke & Leach, 2010). Unmotivated students and uninspiring classroom activities combine to create an overall mediocre educational experience. The summation of the above leaves educational leaders in the United States to grapple with the arduous task of overhauling the educational system (Wagner, 2008).

There are four possible ways to change the fate of a failing school. Each involves the use of a model: the transformation model, the turnaround model, the restart model, and the closer model (Peck & Reitzug, 2014). While all four models are appropriate at different times, each require a significant time investment. These models may prove appropriate at the school level, but a broader approach is needed in order to change the educational practices within the national, state, or local school divisions, such that students are afforded access to effective systems of instruction.

The mathematical diet of children does not have to be one of monotony (Palandri and Sparrow, 2009). Sparrow and Hurst (2008) found that a group of Year 5 and Year 7 children reported that they liked math in Year 3 because of variety. "In subsequent years, however, they worked almost exclusively from textbooks and sheets and reported that they disliked mathematics lessons, and were bored" (p.19). When students are motivated to achieve, most will inherently self-engage in the educational process to facilitate their own achievement. However, this is not the case for all motivated students. Furthermore, there are some students who are not motivated to achieve. Engagement becomes a major issue in these cases. The question then becomes: How can teachers, principals, superintendents, policy-makers and other facilitators of learning, work together to boost student engagement, motivation, and achievement (Bobis, Anderson, Martin, & Way, 2011; Dotterer & Lowe, 2011; Matiti, 2013; Wang & Holcombe, 2010)?

Many believe that eliciting academic engagement hinges on actively incorporating the student's learning style or mode of intelligence (Bobis *et al.,* 2011; de Vires, 2010; Dogan-Temur 2007; Dotterer & Lowe, 2011; Hallam, 2010; Legg, 2009; Matiti, 2013). Though the bodies of research surrounding learning style and multiple intelligence theory are robust, their use is not widely implemented at the school level. According to Hallam (2010) and Legg (2009), this is because standardized test expectations often prompt educational leaders to encourage a kill and drill approach, which can negatively influence the classroom experience and severely impede student motivation and achievement.

Music's positive effects are well supported by research. Tsai, Kunter, Ledtke, Trautwein, and Ryan (2008) conducted a study focused on 7^{th} grade students; the students took a pre-survey on individual interests and characteristics. Next, over a three-week period the same students were surveyed after specific lessons. Tsai and fellow researchers found that there were many factors that determined whether or not a student perceived a lesson as interesting. Amongst these factors were autonomy and individual interest. The research suggests that students become disinterested in mathematics when instructors cover topics that the students consider boring. While what is taught is often non-negotiable, the way in which topics are presented can be addressed. Tsai and colleagues further support the idea that musical stimuli can be used to support student interest (Bobis, Anderson, Martin, & Way, 2011; Dotterer & Lowe, 2011; Matiti, 2013; Wang & Holcombe, 2010).

Problem Statement

The ESEA (2010) was set in place to address concerns about the academic achievement of all students in the core content areas, with a particular focus on reading and mathematics (NCLB; U.S. Department of Education [USDOE], 2010). However, mathematics achievement in the United States continues to be a major area of concern (Wagner, 2008). It is unclear what is causing the stagnation, but it is evident that the No Child Left Behind (NCLB) legislation is not helping to bring America's children up to the level of other developed countries around the world (Wagner, 2008). Henwood and Featherstone (2013), attribute the failure of the law to meet its goals to the way in which it places an intense focus on reading and mathematics, while largely dismissing the arts, history, music, and science. This quantitative study seeks to investigate the impact of non-band music participation on the academic achievement of 6th grade mathematics students. Self-determination theory, multiple intelligence theory, Maslow's Hierarchy of Needs, and brain research provide a theoretical framework (Allcock & Hulme, 2010; Covino, 2002; Deci & Ryan, 2008; Jang, 2008; Ryan & Deci, 2000; Shaw, 2003). The study, within the context of the ex-post facto, causal comparative environment, was concerned with the following research questions:

1. Is there a difference between the mathematics achievements of 6th grade mathematics students based on non-band music participation?

2. Is there a difference between the mathematics achievements of 6th grade males based on non-band music participation?

3. Is there a difference between the mathematics achievements of 6th grade females based on non-band music participation?

Purpose Statement

The purpose of this quantitative, causal comparative study was to test the theories of self-determination, multiple intelligence, Maslow's hierarchy of needs and brain research to examine the impact of participation in non-band music on academic mathematics achievement, after controlling for student aptitude and participation in instrumental music, for 6th grade mathematics students at a mid-sized, central Virginia middle school. The independent variable was defined as participation status in a non-band music class. The dependent variable was defined as academic achievement in the area of mathematics. The confounding variables of student aptitude and teacher styles were controlled.

This research attempted to show that participation in non-band music impacts the academic achievement of 6th grade mathematics students, by comparing students who participate in non-band music and those who do not participate in music. Self-determination theory, multiple intelligence theory, Maslow's hierarchy of needs, brain research, and philosophical connections between the music and mathematics all provide support for this assertion (Bicknell, 2009; Covino, 2002; Deci & Ryan, 2000; Gardner, 2003; Maslow, 1943; Southgate & Roscgino, 2009).

Significance of Study

Because the pressure of high-stakes testing is so pervasive, it is necessary to show that school-based activities contribute to the goal of increased cognition. This study is significant as it seeks to provide evidence of impact by exploring the intersection of mathematics achievement and non-band music participation. Jang (2008) found that students did not want to participate in learning activities that they saw as meaningless or impersonal. Ryan and Deci (2000) stated that motivation is multi-faceted and can be shaped by many different factors, including environment, task, and personal connections. The use of music as part of a viable curriculum can have a positive effect on all three of the aforementioned and therefore promote self-motivation and determination. According to Bicknell (2009), when students engage with music they become better able to function at higher cognitive levels.

Students in middle school mathematics classes, all over the country, report high levels of disengagement and boredom. Lack of instructional practices that are meaningful and motivating to children can lead to low educational achievement and a myriad of other problems. However, the converse is also true. Motivated students can translate into higher levels of engagement and lower levels of conflict (Parker, 2010; Spires *et al*, 2008). The use of music as part of an instructional program at the middle-school level is one motivator that could help to solve problems surrounding subpar educational achievement in the United States.

The results of this study are useful to policymakers and educational leaders alike. Policymakers may use knowledge gleaned from this study to craft policies surrounding the inclusion or exclusion of non-band music classes at the middle school level. Additionally, educational leaders may be further informed about the impact of music on mathematic achievement.

Research concerning the impact of music participation on academic achievement is largely limited to that of the impact of instrumental music instruction at the high school level, and the use of music to teach isolated mathematics lessons on patterns and fractions at the elementary level (An, Ma, & Capraro, 2009; Fauvel, Flood, & Wilson, 2006; Johnson & Edelson, 2003). This research seeks to address a primary gap in the literature, represented by a lack of information on the impact of non-band music participation at the middle school level, on student achievement.

Research Questions and Null Hypotheses

The research questions and null hypotheses guiding this causal comparative study were:

Research Question 1: Is there a difference between the mathematics achievements of 6^{th} grade mathematics students based on non-band music participation?

Null Hypothesis 1: There is no difference between the mathematics achievement of 6^{th} grade mathematics students who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP).

Research Question 2: Is there a difference between the mathematics achievements of 6th grade males based on non-band music participation?

Null Hypothesis 2: There is no difference between the mathematics achievement of 6th grade males who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP).

Research Question 3: Is there a difference between the mathematics achievements of 6th grade females based on non-band music participation?

Null Hypothesis 3: There is no difference between the mathematics achievement of 6th grade females who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP).

Identification of Variables

Operational definitions of key variables are as follows. The independent variable is participation status in a non-band music class. The student groups compared in order to test research question one were a) students who participate in a non-band music class and b) students who do not participate in a music class. The student groups compared to test research question two were a) males who participate in non-band music class and b) males who do not participate in non-band music class. The student groups compared in order to test research question three were a) males who participate in non-band music class and b) males who do not participate in non-band music class. The dependent variable for this study was mathematics achievement, as measured by the 2013-2014 administration of the Northwest Evaluation Association's (NWEA) Mathematics Measures of Academic Progress (MAP) test (Northwest Evaluation Association, 2011).

Definitions

Unless otherwise designated all terms are defined by the author.

Academic achievement: progress towards educational goals as measured by standardized test scores (Hallam, 2006).

Core academic areas: core learning areas include English, reading/language arts, math, science, foreign languages, civics and government, economics, arts, history and geography (ESEA, 2010).

Learning style: a preferred way of using one's abilities in order to gain or acquire knowledge (Pashler et. al., 2014).

Maslow's Hierarchy of Needs: a theory that asserts that as humans grow and mature they move through the stages of physiological, safety, love and belonging, esteem, and self-actualization needs (Maslow, 1943).

Mathematics achievement: a score at or above the benchmark score of 216 on the end-of-year mathematics MAP test.

Motivation: according to Scharacter (2012), motivation is the purpose or the psychological cause of an event, action, or thought.

Multiple Intelligence (MI) Theory – the theory that humans use different modes of intelligence to process and glean information about the world. (Gardner, 1983)

No Child Left Behind (NCLB): commonly used phrase referring to the Elementary and Secondary Education Act (NCLB; U.S. Department of Education [USDOE], 2010).

Non-band music class: an organized class, which takes place as part of the school day that focuses on the learning of music and does not include as its principal component the playing of any musical instruments.

Self-determination theory: a theory of motivation, involving intrinsic motivation, extrinsic motivation, and the intersection of the two. Self-determination theory was first developed by Deci and Ryan (1985).

CHAPTER TWO – LITERATURE REVIEW

Despite evidence that music education may be linked to higher levels of academic achievement, music programs across the country have become subject to reductions and cuts (Major, 2013), (Bicknell, 2009; Covino, 2002). Covino (2002) suggests that students who perform music gain practice using all brain regions in a simultaneous manner, and that this simultaneous brain action is very similar to how the brain works when engaged in critical thinking.

Chapter two presents a review of the literature. The review focuses on the intersection of music and mathematics. A theoretical framework bolstered by self-determination theory, multiple intelligence theory, and Maslow's Hierarchy of needs supports the research. (Allcock & Hulme, 2010; Deci & Ryan, 2008; Jang, 2008; Ryan & Deci, 2000). Additionally, brain research is reviewed as it lends credence to the hypothesized connection between music and mathematics (Cogo-Moreira, deAvila, Ploubudis, & de Jesus Mari, 2013; Covino, 2002; Thornton, 2013). Further, there is a review of theoretical practice, including the intersection of music and mathematics, and how music impacts the mathematics classroom. The literature review goes also includes an in-depth analysis of engagement, motivation, academic achievement cycle, ideas for professional development, and a body of related research.

In order to attain higher levels of achievement, some research suggests that secondary students must first be engaged and motivated to learn (Dogan-Temur, 2007; Jang, 2008; Zepke & Leach, 2010). Further, these studies show that the activities that teachers use in classrooms can impact levels of engagement, motivation, and consequently, achievement. Therefore, improving student motivation and student engagement are correlate goals. When students are motivated to achieve, they will actively participate in the process of education, facilitating their own engagement (Deci and Ryan, 2008; Hallam, 2010). The focus of this research study is the impact of non-band music participation on the academic achievement of 6th grade mathematics students, males, and females.

Mathematics and music are deeply interconnected. Pythagoras thought of the two as one in the same (An, Ma, & Caparo, 2009). Through careful analysis and synthesis, one is able to reach the conclusion that using music in order to teach mathematics will serve to motivate students, as well as aid students in their acquisition and retention of mathematical knowledge. The widely accepted multiple intelligence theory asserts that one type of intelligence is musical. Just as one might focus on spatial or linguistic intelligence, teachers can attempt to tap into this mode of intelligence to instruct within the core subjects. For some children, musical intelligence is the modality through that they will learn most successfully. Using music to teach mathematics is well supported by many studies that have examined the effects of learning within one's preferred learning style on student learning and retention (Allcock & Hulme, 2010; Jang, 2008; Johnson & Edelson, 2003).

Theoretical Framework

Self-determination theory, multiple intelligence theory, and Maslow's Hierarchy of needs work together to provide a framework for a hypothesized impact of non-band music class on mathematics achievement (Allcock & Hulme, 2010; Deci & Ryan, 2008; Jang, 2008; Ryan & Deci, 2000). Additionally, brain research conducted by Covino (2002), Shaw (2003), and others support a connection between music and the successful learning of mathematics and higher order thinking skills.

Self-Determination Theory

According to Deci & Ryan (2008), self-determination theory "addresses such basic issues as personality development, self-regulation, universal psychological needs, life goals and aspirations, energy and vitality, non-conscious processes, [and] the relations of culture to motivation" (p.182). Self-determination theory purports that environmental and social supports promote student motivated, positive behaviors and engagement in student learning (Deci, Vallerand, Pelletier, & Ryan, 1991). Educational policy makers have an interest in ensuring that all students have the motivation they need to achieve in school. This is an arduous task because helping a child feel supported is as specific to each child, according to his or her set of intelligences and learning strengths. Research links the self-determination of a student to his or her feeling that he or she is being respected as a learner (Allcock & Hulme, 2010; Jang, 2008). Hence, it is important to study the impact of teaching and learning in a manner that activates one's preferred learning style in order to increase student engagement, motivation, and academic achievement (Allcock &Hulme, 2010; Jang, 2008; Johnson & Edelson, 2003).

Multiple Intelligence Theory

One school of thought purports that students will feel supported when and if their individual learning styles are considered and actually supported during the planning and implementation of curricular activities (Caruthers, 2009; Deci & Ryan, 2008). This can be accomplished in many different ways because each learner is an individual with a very personal, specific background, with various tendencies for learning and a unique set of intelligences. Gardner asserts that one way to group and or classify students in order to better instruct them is to identifying and adjusting for their differing styles of intelligences. Further, it is set forth that all students are intelligent and that it is the job of the instructor to identify and tap into the multiple intelligences among different learners – including linguistic, musical, logical, mathematical, spatial, bodily-kinesthetic, interpersonal, intrapersonal, existential, and naturalistic (An, Ma, & Capraro, 2009).

Music participation as a beneficial act is grounded in Gardner's (1983) Theory of Multiple Intelligences. Gardner (1996) stated that intelligence is "the ability to solve problems, or to fashion products, that are valued in one or more cultural or community settings" (p. 7). The theory supports the idea that students solve problems in a variety of different ways. Gardner's (1983) theory suggests that intelligence transcends what is measured by a standard Intelligence Quotient (IQ), as this tool only addresses one mode of intelligence, while Gardner's original work identified seven: linguistic, logical-mathematical, spatial, musical, bodily kinesthetic, interpersonal, and intrapersonal.

Gardner's inclusion of musical intelligence has been used as a basis for the study of musical instruction at the elementary school level (De Vries, 2010; Hallam, 2010) to examine the impact of music education on academic performance and teaching certain mathematical concepts through music at the secondary level (Major, 2013; Cox, 2006; Fitzpatrick, 2006; Kinney, 2008). Multiple intelligences are often discussed as a subset of learning styles and/or a different way to describe the style of a learner. Allcock and Hulme (2010) assert that the term "learning styles" has become pedagogically popular, and therefore, it is often referred to by many names, including cognitive styles and multiple intelligences. Attention to multiple intelligences has been shown to boost student motivation and, therefore, has a positive effect on student achievement (Jang, 2008; Johnson & Edelson, 2003).

Maslow's Hierarchy of Needs

According to Maslow's (1948) theory, individuals attend to their needs starting with the most basic. For middle school students, learning is not always at the top of their list of needs. Chapman (2013) asserts that "middle school students who struggle with poverty or live in areas with safety concerns often struggle to have the basic levels sufficiently met and are therefore unable to progress to the self-actualization or self-transcendence levels" (p. 21). These students are often the same ones who do not participate in instrumental music. However, students of low-socioeconomic status do participate in non-band music class to a higher degree (Venter & Venter, 2010).

Chapman (2013) also highlights that "Maslow's Hierarchy of Needs theory explains "personal motivation and the need to have basic needs met before being able to progress to higher levels of motivation" (Maslow, 1948; Sadri & Bowen, 2011; p.20). This is an assertion that educational leaders and policy makers must understand, as they are charged with having the necessary programs in place to support the positive fulfillment of needs, allowing students, teachers, and other instructional personnel to assess which needs are not being met (Juliano & Sofield, 2011).

Brain Research

Proponents of using music to strengthen mathematic achievement can use self-determination theory as well as multiple intelligence theory in order to bolster their arguments. Additionally, scientific research between the two disciplines supports their connection. Johnson and Edelson (2003) assert that music enhances temporal-spatial reasoning and thereby provides crucial support in learning mathematical concepts, such as proportional reasoning and geometry. According to Helmrich (2010), both music and mathematics engage the prefrontal cortex and the parietal lobe of the brain. Because music can be used to strengthen these parts of the brain (through usage), it is helpful to children and adolescents attempting to learn mathematics. Hallam (2010) adds to this connection by asserting that through extensive, active engagement with music cortical reorganization may occur, and therefore, music can actually spawn a functional change in how the brain processes musical and mathematical information. This research is especially salient when considering how many students struggle with the conceptual aspects of mathematical thinking.

Ellison (2001) contends that synaptic connections are formed as students learn. “In this forming of synaptic connections, students, who are involved in music, form more synapses between brain cells. As these synapses develop, the capacity of the brain to retain information is increased” (Boyd, 2013 p. 34). Strickland (2002) asserts that by the time students are three years of age certain synapses will become extinct. Of the remaining synapses, approximately half will remain active through adulthood. Music serves as a tool during the early years to stimulate the brain, allowing the proper synapses to be eliminated and proper channels for processing information and critical thinking to take place.

Another strong connection between music and mathematics can be explained through the examination of the processes of synaptogenesis and synaptic pruning. The brain is constantly forming new connections or synapses; however, between the ages of 10 and 12, there is a surge of new synapse formation called synaptogenesis. This process is followed by a period of synaptic pruning when the brain eliminates weak neural pathways and strengthens those that are being used regularly (Helmrich, 2010). Since music and mathematics are both being processed in the prefrontal cortex and the parietal lobe of the brain, music can ensure that the synapses needed for mathematics stay active and avoid being purged during the process of synaptic pruning.

Covino (2002) conducted a study using Functional Magnetic Resonance Imaging (fMRI). The study found that when brain scans were taken of students engaged in music (choral or instrumental) all major areas of the brain were receiving blood flow. An increase in brain region usage is associated with greater degrees of emotion and an increase in pathways for recall.

Covino and Shaw (2003) both report that music has the ability to increase the ability of the brain to reason aiding movement, motor skill development, and memory. Covino also found that students who participated in music instruction were processing information more efficiently than their non-music peers. Covino asserts that these differing levels of processing ability may be due to the part of the brain called the corpus callosum. The corpus callosum is the part of the brain that attaches the left and right hemispheres. Cox and Stephens (2006) support this idea with research that identifies a connection between music students and enlarged corpus callosum brain regions.

Self-determination theory, multiple intelligence theory, and brain research, work together to establish a strong connection between music and mathematics. Further, music is even more beneficial when one considers its inherent motivational aspects (Dogan-Temur, 2007; Jang, 2008; Zepke & Leach, 2010). This research is of great importance as it seeks to fill a gap in the data represented by the lack of focused research on the impact of non-band music participation on mathematics achievement at the middle-school level.

Theoretical Practice

Engagement and Motivation Methods

Turner, Warzon, and Christensen (2011) contend that "instructional strategies that foster working productively with others can support belongingness" (p.791). The importance of this assertion is magnified when one considers that school aged children are actively building identity (Mora, 2011; Spires *et al.,* 2008). Mora (2011) conducted an ethnographic study that focuses on how Latino middle school boys construct identity. The study found that the process of building identity was influenced by both classroom dynamics and the curriculum being delivered. The findings of this study are significant within the educational community because they suggest that teachers must actively construct a positive classroom atmosphere in which each student has the support that he or she needs to learn. Additionally, classroom activities must be constructed and carried out in a manner that encourages the building of student identities. This quality of this study is such that, conclusions can be generalized and are therefore not limited to middle school, Latino boys.

Spires, Lee, Turner and Johnson (2008) also conducted research on how classroom dynamics shape the experiences of middle school students. This examination focused on the connection between middle school student's use of academic technologies and academic engagement, and it was found that, overall, middle-school students in the study preferred to use technology freely and work in small groups. Other details related to technology usage were varied. The article highlights commonalities in what middle-aged students want, noting that most preferred to use technology and work in groups. It also calls attention to idea that students are individuals for whom curriculum must be differentiated in order to spur motivation, even when using teaching methods and practices that have been deemed effective for middle grade students.

According to Turner, Warzon, and Christensen (2011), "when teachers and administrators name their most pressing concern, they often reply student motivation. Educators readily confess that they are confused and ill prepared to address what they regard as student disinterest and lack of effort" (p.719). Turner and colleagues conducted a study specifically targeting student motivation in the area of mathematics. The research used a qualitative case study approach to examine if and how teacher practices and sentiments about mathematics changed over a nine-month collaboration period. The changes were focused on mathematics efficacy and motivation. The findings reported are related to those of the Spires collaboration

(2008) and Mora (2011). Changes are focused on mathematics efficacy and motivation. This solidly delineates the connection between teacher efficacy for the subject of mathematics, teacher instructional practices, and student motivation – helping to move theory into educational practice.

Music and Mathematics

When considering multiple intelligence theory and meaningful applications, educators may find it difficult to identify concrete ways of making connections to mathematics. One mode of intelligence that can be easily tapped into is musical intelligence, as music and mathematics are connected (An, Ma, & Capraro, 2009; Hallam, 2010; Helmrich, 2010; Legg, 2009; Southgate & Roscigno, 2009). The notion of intertwining mathematics and music is not a new one. In fact, as early as the 6^{th} century BC, the Greek philosopher Pythagoras found ratios amongst music intervals. However, in many classrooms across America, all of the arts, including music, are separated from instruction. When inclusion does occur, it is usually in a superficial manner (An, Ma, & Capraro, 2009). The Greek philosopher "Pythagoras envisioned a living cosmos comprised of ratios and he and his students devoted themselves to articulating these relationships. Math and music were one and the same to the Pythagoreans" (Southgate & Roscigno 2009).

One might argue that a supposed connection between math and music by Pythagoras is not enough to warrant music inclusion in the math classroom, and many would agree. If fractals represent the entirety of the connection, then music and math are not as intertwined as Pythagoras once thought. However, An, Ma, and Capraro (2009) cite a robust relationship between music and mathematics, asserting that music is both internally and externally related to mathematics, on multiple levels, and that music and mathematics education can be intertwined from kindergarten through college (2009). For example, musical elements like notes, scales and tuning are related with many areas of mathematics, from proportions and integers to geometry to trigonometry (An, Ma, & Capraro, 2009; Fauvel, Flood, & Wilson, 2006; Johnson & Edelson, 2003).

Kinney (2008) conducted a study to identify a correlation of higher standardized test scores of students who participated in 6th and 8th grade performance ensembles. The study examined the students before 4th grade in order to gain a baseline, then again when the students were in 6th grade and 8th grade. The findings of the study showed that within the group of band students, those with a higher socio-economic status scored higher than those students classified as having a low socio-economic status. Additionally, 6th grade band students scored significantly higher than choir students and those students who did not any musical course on every academic achievement test. The overall findings further suggest that middle-school band attracts high achieving students, and therefore, score differentials between those students who are and those who are not in band remain divergent. However, Fitzpatrick (2006) conducted a study in which academic achievement scores for students with low-socio economic status surpassed that of students of high socio-economic status, who had *no musical involvement,* lending credence to the hypothesis that music boosts academic achievement.

The Turner study (2011) proposes that "there is a strong tradition in mathematics instruction that focuses on teaching sets of procedures and operations to solve problems, emphasizing correct solutions and teacher control of student learning". The research also suggests that teacher-controlled classrooms fail to result in positive student engagement, motivation, and academic achievement (Mora, 2011; Spires *et. al,* 2008; Turner, *et al.* 2011). Hence, teachers must look to reshape classroom activities so that they are student centered, particularly in the area of mathematics. According to Valas and Sovik (1994), intrinsic interest, performance, and self-concept related to mathematics are affected by the controlling strategies of the teacher.

An, Ma, and Capraro (2011) also conducted a study to test the impact of musical mathematics lessons. The study found that there was a significant mean increase between the pre-test and post-test Mann-Whitney U Test scores mathematics attitude, surveying scores of students after participating in a musical mathematics lesson. Like the work of Valas and Sovik (1994), this study highlights the influence that music can have on the mindset of students, as both articles focus on music creating a change in mathematical sentiment.

Dogan-Temur (2007) found that when using multiple intelligence theory "during the teaching activities performed that students actively participate in lessons; their interest level rise with the rich activities performed; and they are more aware of their abilities" (p.90). Dogan-Temur's (2007) study further concluded that when classroom activities were performed based on multiple intelligence theory, the result was a permanent rise in academic achievement scores. These findings lead many to want to formally assess intelligence and then adapt teaching styles. However, Gardner (1996) reports that this is unnecessary. In support of Gardner 's (1996) sentiments, Jang, Reeve, Ryan, and Kim (2009) conducted a series of four studies to examine whether or not Deci and Ryan's (1985) self-determination theory can explain satisfying learning experiences of Korean students. The study found that relatedness that can be built through the use of lessons tailored to different intelligences; this did not sway Korean students, as collective achievement remained high across all circumstances.

While all of the aforementioned findings are significant in the educational community, it is important to note that music is not the best learning tool for all students; competence, autonomy, and relatedness are all determining factors in self-motivation (Ryan and Deci, 2000). Gardner (1996) believes that data on how students learn best is best collected using informal means, such as classroom observations. Additionally, Gardner suggests that teachers and other instructional personnel have open conversations with students, asking about times when they have had successful learning experiences and how they learn best.

How Does Music Impact Mathematics in the Classroom?

Allcock and Hulme (2010) took on the study of learning styles in the classroom to see if they really have an educational benefit or are simply used for planning with no real merit. Their research focused on Gardner's theory of multiple intelligences, citing Gardner as the leading force in learning style theory. They refer to Gardner as a proponent of individualized education that focuses on matching teaching to learning styles and attacking new topics in a variety of ways, in hopes that one meshes with the learning style of the learner. However, they also point out that this may be an unrealistic expectation for teachers to try and achieve in a classroom full of individual learners, who all have their own learning styles – a notion supported by Gardner himself (1993).

The challenge of multiple intelligence theory is not limited to expectations. Other challenges to multiple intelligence theory cited by Allcock and Hulme (2010) include (1) whether or not a particular task lends itself to one intelligence or another and (2) the availability of resources needed to address so many intelligences on a consistent basis. Furthermore, the authors point out that research done on the effects of multiple intelligence focused tasks is inconsistent because at times it is shown to have no significant educational impact, as was the case when Allcock and Hulme conducted their own research.

The research of Allcock and Hulme (2010) dismisses the use of multiple intelligence theory as a teaching practice, and therefore, this weakens the argument for using music to increase mathematics achievement. However, the authors also state some positives arising from the use of learning styles in education. Some of these include allowing for the identification of the individual needs of learners, boosting self-awareness, and informing an array of teaching and learning methods (2010). With this statement, the authors give credence to the idea that using learning styles is not what brings about student success, but that combined with treating the students like individuals, acts to let the students know that they are important. Additionally, the aforementioned makes the students more meta-cognitive about their learning. With these tools, student motivation rises, and they become more self-determined to learn.

To put theory into practice, one must focus on the integration of one type of intelligence at a time, while realizing that effective instruction will encompass all of the intelligences, over a period of time. Many make the mistake of focusing on one or a few learning styles and/or modes of intelligence to the detriment of the others. This kind of implementation is opposed to that of Gardner (2003) who believes that each student is an individual with their own preferred set of intelligence-based strengths and weaknesses. Contrarily, when students are taught through many different modes of intelligence, they are afforded the opportunity to use their strengths and work in areas where they may be weak.

In a 2008 study, Jang found that students do not want to participate in learning activities that they see as meaningless or impersonal. Ryan and Deci (2000) also stated that motivation is multi-faceted and can be affected by many different factors, including environment, task, and personal connections. The use of music in the mathematics classroom can serve to positively modify all three of the aforementioned and therefore positively alter ones self-motivation and determination.

Shilling (2003) very specifically focused on the power of music as a stimulant for accessing student engagement. Stating that music is a tool, which almost every child has in their proverbial toolbox, and one that often goes unused in the core subject areas, especially as students grow older. Shilling's work highlights the connections between music and fractals in the same manner that many have before him, but the author also points out that it is not necessarily this natural connection that is useful in teaching. Rather, it is student enchantment with music that sparks student's interest and keeps them engaged in lessons from start to finish. It is this enchantment that Shilling suggest be cultivated for educational benefit.

When considering lessons that integrate music and math to a high degree, Box and Watson (2010) stressed that students may actually become confused and begin to question whether they are learning music or mathematics. This sentiment echoes that of Pythagoras, that math is music and music is math, and when engaging one discipline or the other, one is actually engaging both (An, Ma, and Capraro, 2009).

Lack of instructional practices that are meaningful and motivating to children can lead to low educational achievement and other problems. However, the converse is also true. When students are motivated, this can translate to higher levels of engagement and lower levels of conflict (Parker, 2010; Spires *et.al,* 2008). The use of music as an instructional practice at the middle-school level is one such motivator that could increase motivation.

Engagement, Motivation, Academic Performance Cycle

Many times when students attend classes, they are present during lessons and other learning activities, but they do not learn. One reason for this is that some students misbehave. "When students misbehave, they are disruptive to their classmates and teacher, less engaged in lessons, and consequently perform worse in school" (Brackett, Reyes, Rivers, Elbertson, &

Salovey, 2012). This statement highlights the negative ramifications of student misbehavior, and while these effects are note-worthy, it is crucial that educational leaders attempt to note the causes for this misbehavior. Students misbehave for a myriad of reasons. Donner and Shockley (2010) purport that one reason why students misbehave is the lack of motivation. When students are unmotivated, they struggle to learn and retain information; this academic struggle often leads to increased lack of motivation. Consequently, students are less engaged, leading to more academic struggles. Hence, there is an explicit, cyclical connection between motivation, engagement, and academic achievement (Calhoun, 2011; Donner & Shockley, 2010; Wu, Hughes, and Kwok, 2010).

Tackling Boredom

When students report that they are bored, they are attempting to report that the curricular activities in which they are asked to participate are neither engaging nor motivating. Research shows that one way to attack this trend and engage and motivate students is to actively incorporate different modes of intelligence and learning styles (Dogan-Temur, 2007; Legg, 2009). While this research is widely conducted and thought to be sound, in practice, consideration of multiple intelligences and learning styles in classrooms is rare practice. Instead, teachers all over the United States are yielding to pressures to perform on standardized measures, leading many to use uninspired approaches to raise pass rates (Legg, 2009), and consequently impeding student engagement and motivation.

To compound matters, many teachers harbor memories from their own school days. They remember some fun, engaging times, and they remember many other times when they were asked to complete mundane, uninspiring tasks. When translating these memories and preconceived notions into practice, teachers try to decide whether they will have an engaging lesson, a motivational lesson, or one that teaches students what they need to know. The question becomes engagement, motivation, or academic achievement? According to Donner and Shockley (2010), the answer is all three because "achievement requires a pedagogical approach that: (a) teaches students to pursue 'academic excellence,' (b) utilizes students' culture as a vehicle for learning" (p. 51)". As teachers learn to instruct in a manner that meets the engagement needs of their students, motivation and academic achievement will follow.

The words of Donner and Shockley (2010) solidify the assertion that learning must not be sacrificed for the sake of engagement or motivation. When attempting to break a cycle that leads to low achievement, teachers must adhere to high academic expectations through the creation of learning experiences. Wagner (2008) explains another way to frame these learning experiences by suggesting that teachers and other educators must work to create certain conditions. These conditions are ones in which students may thrive, and essential to their creation is the teacher's belief that students can be engaged, motivated, and still make meaningful academic progress. When teachers harbor this belief, they work to create such environments, but too many teachers think that that the aforementioned is not possible. In order to address low levels of engagement, lack of motivation, and poor academic performance, educational leaders must provide professional development aimed at training teachers and other instructional personnel to address each component of the cycle.

Culturally Responsive Classrooms

While motivation is important, one cannot discount the impact of low student engagement. Calhoun (2011) maintains, "While many have argued that boredom is caused by an absence of meaning in our lives, it's equally obvious that boredom often motivates indulgence in meaningless activities" (p. 270). It is these meaningless activities or the repetition thereof that can lead to classroom conflict. Some reasons for boredom are outside the locus of teacher control. However, one aspect that instructors have autonomy over is whether or not the classroom is culturally responsive, which has been shown to boost both student engagement and motivation (Abdallah, 2008; Gorey, 2009; Spires *et.al,* 2008).

In order for a classroom to be culturally responsive, the teacher as the literal and figurative leader must employ culturally responsive teaching practices. Colbert (2010) defines a culturally responsive teacher as one who has a high level of socio-cultural consciousness. Colbert goes on to say that the way in which any one person sees the world is affected by his or her life experiences, and this can be tempered by race, ethnicity, social class, gender, and much more. Porto (2010) confirms Colbert's notion stating, "Culturally responsive teachers make connections with their students as individuals, while understanding the socio-cultural and historical contexts that influence their interactions" (p. 57). When teachers adopt these practices, students in the classroom are apt to do the same.

Many teachers employ some level of culturally responsive teaching practices as an automatic reaction to unmotivated students. Therefore, understanding that low student motivation is a crucial component of the low engagement, low achievement cycle only increased the expressed need for these practices to be in place. Donner and Shockley (2010) state that those who are unmotivated often struggle to learn and retain information. However, when motivation is present, students were less negative and more engaged; and this, according to Crow (2011), reduces conflict antecedents. Donner and Shockley go on to say that we must utilize students' cultures as their vehicle for learning. In this manner, they suggest that by emphasizing the multiple learning methods that have been proven effective in different cultures, we can effectively teach all students (2010).

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When students are taught in culturally responsive classrooms, they feel better about themselves (Parker, 2010; Sparrow and Hurst, 2010; Spires et. al, 2010). In contrast, the alternative may lead to conflict, as students are unsuccessful and motivation wanes. This occurs when the students cannot connect to classroom practices. One of the reasons that this disconnect may occur is learning style. Rapp (2009) suggests that teachers can often turn children off students to particular subjects or school as a whole by not allowing for differing learning styles. However, this dissonance can be avoided through the careful integration of cultural responsive practices (Rickard, Vasquez, Murphy, Gill, & Touksati, 2011; Sparrow and Hurst, 2010).

For some, the term culturally responsive immediately conjures images of students of differing colors and races. While creating a culturally responsive classroom may involve adapting for students of different races and or ethnicities, there are many other factors that make up ones culture. This means that every classroom has the need to be culturally responsive, for merely two students constitute a diverse group. Consequently, when a teacher cares to seek out and nurture the differences that exist, culturally responsive teaching practices can be employed, and a seed for a culturally responsive classroom is sewn (Parker, 2010; Souto-Manning and Mitchell, 2010).

In order to build a culturally responsive classroom, as the leader, the teacher must: get to know the students; plan to be culturally responsive; be inclusive; remain flexible; and stay positive! Colbert (2010) asserts that each person's sense of culture is comprised of many different characteristics. These characteristics reach far beyond race and ethnicity to include commonly considered aspects like communication, language, and appearance. However, there are many more that go largely ignored, such as each student's sense of status and age relationships and mental processing and learning tendencies. Wu, Hughes, and Kwok (2010) support Colbert's assertions and insist that getting to know one's students is an active process in and of itself. Student records and forms can be a useful starting point in learning about students; in addition, student writing and pictures can be a primary source of information. Surveys can also be a good way to collect a lot of information quickly, but the best way to learn about students is to look and listen to students on an everyday basis.

Throughout the process of establishing an idea of each student's culture, teachers should plan overt acts of culturally responsiveness that span the entire school year. This plan is crucial because Porto (2009) asserts that honoring linguistic, social, and cultural diversity in the classroom is of the utmost importance when attempting to teach in a culturally responsive manner. In order to learn about other cultures, it may be necessary to locate cultural informants who are familiar with members of a certain culture and can offer explanations. Informants can be used in conjunction with a concerted effort to identify and use different manifestations of a culture in the classroom that include food, artwork, dress, etc.

For teachers just starting on the road to using culturally responsive teaching practices, focus can be placed in the particular on four Fs: Food, Fashion, Festivals, and Folklore (Porto, 2009). However, these big events and happenings are only a small portion of what is needed to create a culturally responsive classroom. Far more important are the everyday acts of cultural integration and responsivity. Porto (2009) goes on to proclaim that teachers must provide abundant information about other cultures. This information should be presented in a manner that portrays positive, realistic images of other cultures. According to Souto-Manning and Mitchell (2010), ¨Being inclusive does not take a *cafeteria* sampling approach to culture" (p. 271). Instead, it should hinge upon a developed plan and inviting parents (and other caring adults) to share their cultural practices and "encouraging cultural practices from the home to enter the classroom in authentic and respectful manner" (Souto-Manning and Mitchell, 2010 p. 271). Using these methods, the level of inclusivity within the classroom was significantly increased.

Finally, it is important to note that creating a culturally responsive classroom requires a great amount of flexibility and a positive attitude. As teachers adapt their classroom instruction, as well as their procedures to meet the needs of all students, these adaptations will allow for less conflict, greater engagement, and higher levels of achievement. At the same time, there are some things that must remain rigid when teaching in a culturally responsive manner. "Achievement requires a pedagogical approach that: (1) teaches students to pursue 'academic excellence,' (2) utilizes students' culture as a vehicle for learning." (Donner & Shockley, 2010 p. 51). Maintaining standards for high levels of academic excellence is a must and works well when used in conjunction with the use of culture as a vehicle for learning (Gorey, 2009). Latipun, Nasir, and Khairudin (2012) purport that "congruence, positive regard, genuineness and empathetic understanding act to create a therapeutic condition in which persons are willing to solve problems, and harbor a positive attitude" (p. 8). Latipun *et al*. goes on to say, "Teachers and other educators must see themselves as working to create the same conditions for these are the conditions under which many conflict antecedents are not present" (p. 8). The best way to remain positive is to stay focused on the relationship between low levels of conflict, high engagement, and high achievement (Calhoun, 2011; Parker, 2010; Porto, 2010).

Music can assist teachers in creating a culturally responsive classroom. According to Porto (2010), "Culturally responsive teachers make connections with their students as individuals, while understanding the socio-cultural and historical contexts that influence their interactions" (p. 57). It is through the use of culturally responsive teaching practices that students who at times seem unreachable can become motivated to learn. This motivation translates into greater engagement and lower levels of conflict (Spires et. al, 2008; Parker, 2010). In order to teach in a culturally responsive manner, teachers should first analyze their own culture. Once teachers realize how their own culture influences who they are and how they see the world, then they will have taken the first step towards creating a culturally responsive classroom, thereby reducing conflict antecedents and improving student motivation and achievement (Doppler-Bourassa, Harkins & Mehta 2008; Gorey, 2009).

Cheryl Periton (2013) reported Plato's thoughts about music training declaring that it "is a more potent instrument than any other, because rhythm and harmony find their way into the inward places of soul, on which they mightily fasten, imparting grace, and making the soul of him who is rightly educated graceful. . ." (428 -348 BCE). Periton also notes that composers use the Fibonacci sequence in music, and that the golden ratio is often used to exemplify beauty and art. This suggests that sometimes mathematics is rational and sometimes it is abstract. That is, sometimes mathematics is the performing of a ration and sometimes it is objective. Russian composer Igor Starvinsky said that music is a very closely linked form of mathematics. Starvinsky differed from Plato, in that he did not think that music was math itself, but akin to mathematical thinking and reasoning. Linking music in mathematics in this way suggested music has a duality. Music acts as a tool for describing the world, tool that can bridge cultural divides, and provide listeners and makers with a sense of humanistic identity (Periton, 2013).

Professional Development

In order to change teacher sentiments and ideas about what can be done in the classroom, professional development is needed. The right professional development can bring about ontological development rather than a schema evolution. Noy and Klein (2004) explain this process. While, "the main goal for schema-evolution support in databases is to preserve the integrity of the data itself" (p. 430) this is not the case with ontological development. Schema-evolution comes with the limitation of revision. One must ask, "How does the new schema affect the view of the old data? Will queries based on the old schema work with the new data? Can old data be viewed using the new schema" (p. 430).

According to Noy and Klein (2004), the same issues are applicable to ontological data, but ontology is larger than specific data points. It can be conceptualized as larger "'schemas for knowledge bases' having defined classes and slots in the ontology, we populate the knowledge base with instance data" (p. 430). However, ontologies, unlike schemas, work to further spur inquisitions, making ontology development more conducive to education. Children are not all the same, and they will not all respond to lessons and learning environments in the same manner. Hence, ontological development will assist teachers in conceptualizing teaching and learning in a manner that is adaptable (Marshall, 2014).

Professional development must also include a variety of techniques aimed to assist teachers in tackling the engagement, motivation, and academic performance cycle. Souto-Manning and Mitchell (2010) found that the most effective methods for training teachers include tackling issues through professional development and participating in pre-service teacher trainings. Turner, Warzon, and Christensen (2011) also referred to the positive effects of professional development, calling it the best way to shape the beliefs and ideals of educators. This shaping of ideals and beliefs can create the ontological development necessary for teacher growth.

What Kind of Professional Development

When assisting teachers and other instructional personnel learn how to engage and motivate students, it is important that the professional development they receive is both engaging and motivating. While the aforementioned idea appears elementary, it is one that is often missed because many teachers receive professional development in the form of large group lectures. Therefore, educational leaders must think beyond hours of sitting, and even beyond podcasts, to what instructors can *do* in order to develop their expertise. Professional development must focus on modeling by experts and the process of action research (Souto-Manning & Mitchell, 2009; Turner, Warzon, & Christensen, 2011).

Blackaby and Blackaby (2011) assert that leaders must model the way. This is an idea essential to developing the ability to create academic environments that are both engaging and motivating. When principals and division-level leaders show teachers that the creation of positive motivating environments is possible during professional development, ontological development occurs (Noy & Klein, 2004). This allows instructors to conceptualize teaching students with a new state of mind. Teachers and other instructional personnel must also be given the opportunity to try out their new ideas and see what works. According to Souto-Manning

(2010), ‘‘a teacher researcher, among other things, is a questioner. Her questions propel her forward” (p.271). It is this forward-thinking nature of action research that allows it to fit so well with the act of bringing about ontological development. It is also this effect that allows teachers to move beyond the ideas that they harbor from school days past into the present, such that students are not continuously fighting boredom (Calhoun, 2011).

Lynch (2012) purports that a principals and other school leaders must operate in multiple capacities, fulfilling many different roles, depending on the time and situation. It is important to note that principals must be cognizant to attend to their role as staff developer. It is only through professional development that teachers can develop the ontology needed to conceptualize, create, and effective learning situations for students (Souto-Manning & Mitchell, 2009; Turner, Warzon, & Christensen, 2011). In summation, educational leaders can provide professional development for teachers and other instructional personnel to address low levels of engagement, lack of motivation, and poor academic performance. This professional development must itself be engaging and motivational, taking the form of modeling, action research, or a combination of the two.

Overview of Related Research

Music participation and academic achievement have often been associated with one another. Morrison (1994) used data from The National Center for Educational Statistics in a study with a large sample size of 13,327 students. High school sophomores who participated in music had higher grades in the area of math, as well as science and history, when compared to those who did not participate in music. This allows one to assert that music participation may aid in mathematics achievement.

Research by Allcock and Hulme (2010) found that there might be another possible explanation for the link in achievement. The researchers suggest that is not music participation that causes higher achievement; instead, it is the intervening variable of higher grades at the. Hence, music participation may or may not be a contributing factor to higher grades. Specifically, the relationship may be correlative, instead of causal.

Geist, Geist, and Kuznik (2012) conducted qualitative research that found music to be a useful tool in the pre-school classroom. From this research, the authors asserted "with new understanding about the nature of everyday learning experiences, the key role of patterns in the development of literacy and mathematics, and the need for a stimulating environment in the very early years" (p.78). It is important to note that the aforementioned study only professes to report upon the effects of music for very young children. However, the authors suggest that music can engage even the *youngest* children in the process of learning mathematics. This statement suggests that music may boost mathematical engagement at later points in life.

Academic Achievement

Numerous studies expound upon the relationship between music and academic achievement. The body of research crosses the areas of reading and language arts, mathematics, science, as well as other social disciplines. While some studies utilize data from teacher-made assessments, others employ more standardized metrics. According to Hodges and Connell (2007), these include:

- American College Test
- Basic Skills Assessment Program
- California Test of Basic Skills
- Comprehensive Tests of Basic Skills
- Cornell Critical Thinking Tests

- Florida Comprehensive Achievement Test
- Georgia High School Graduation Tests
- Iowa Tests of Basic Skills
- Kentucky Instructional Results Information System assessment scores
- Metropolitan Readiness Tests
- (New Jersey) Grade Eight Proficiency Assessment
- Scholastic Assessment Tests
- Stanford Achievement Test
- Stanford-Binet Intelligence Scale
- Texas Educational Assessment of Minimum Skills
- Tests of Achievement Proficiency
- Texas Assessment of Academic Skills
- Texas Assessment of Knowledge and Skills
- Torrance Tests of Creative Thinking
- Wechsler Intelligence Scale for Children
- Wechsler Preschool and Primary Scale of Intelligence
- Wide-Range Achievement Test-III
- Woodcock Johnson Tests of Achievement
- Standardized music assessments include;
- (Colwell) Music Achievement Tests
- (Gordon) Primary Measures of Music Audiation
- (Gordon) Intermediate Measures of Music Audiation
- (Gordon) Music Aptitude Profile

- (Seashore) Measures of Musical Talents
- Watkins-Farnum Performance Scale (p. 2-3)

Sample sizes for the studies varied greatly, ranging from 42 to over 17,000. The aforementioned measures have been used to test students from different age groups, including preschoolers, elementary school age children, middle and high school students, as well college students. When one analyzes the types of music experiences that have been tested most often, they can be categorized into two main groups: high school band and general music instruction at the elementary school level.

Support for Music Instruction

There is support for the assertion that students who participate in music education courses have higher levels of academic achievements when compared to those who do not participate in music education courses. Three studies that support this assertion include Cardarelli (2003), Schneider and Klotz (2000), and Trent (1996). Caradarelli (2003) examined the standardized test scores of third-grade students who received instrument-based (i.e., instrumental) music instruction. The third graders in the study were not instructed in a traditional manner. Instead they received lessons specifically designed for urban students, or those of low-socioeconomic status. Upon completion of the instruction, Caradarelli examined the mean scores of those students who received music instruction and those who did not, and he determined that the music instruction had a positive effect on academic achievement.

A 2000 study by Schneider and Klotz investigated participation in extracurricular, athletics, and participation in music performance groups (band or chorus). The study followed 346 fifth and sixth grade students through the ninth grade. The findings showed that while the musicians scored higher than those students in the athlete group, scores were not significantly higher than the non-participant group. Further, the study revealed that while the athlete and non-participant groups showed drops, the musicians exhibited a tendency to have more stabilized scores.

Trent's (2006) study used archival data from two similar high schools. Students from both high schools were separated into two groups: those who had participated in instrumental music programs from 6th to 12th grade and those who had not. The study found that students who participated in instrumental music programs (band, ensemble, strings) scored significantly higher than those who had not.

Five other experimental studies aimed to test the effects of music instruction on academic achievement have been identified. Of these five, three support the assertion that music has a positive effect on academic achievement. Olson (2012) studied first, second, and third grade students and found the female participants who participated in music instruction made improvements in mathematics all three years, while male counterparts made gains in reading at the first and second grade levels. These findings support the notion that music has a positive impact on academic achievement and that there are differences in the way that music instruction affects male and female students. Hoffman's (1995) study of fifth graders – those who received text-based music instruction and those who received keyboard instruction – concluded that the keyboarding group made greater gains in the area of mathematics. Further, Barr, Dittmar, Roberts, and Sheradan (2002) conducted a similar study that tested the overall effects of music instruction in combination with a 16-week program designed to improve overall listening skills. Results from this study confirmed the work of Trent (2006), suggesting that music had a positive effect.

The work of Barr and associates (2002), Hoffman (1995), Olson (2012), and Hines (2000) found that the type of instruction (music or non-music) that students received had no impact on reading or mathematics achievement. Additionally, Legette (1993) found that students in third, fourth, and sixth grades who participated in music instruction did not demonstrate improvement in academic performance, when compared to peers with no music instruction.

Music and Mathematics in the Technology Age

Gardner's (1983) Theory of Multiple Intelligences and Maslow's (1943) Hierarchy of Needs are seminal works used to explore connections between music and mathematics, and they provide the foundation for this research, which is a body of past research. However, there is a lack of current information surrounding music education and mathematics, as educational technology has changed the educational landscape. Twenty-first century technologies have largely replaced music and other arts programs across the country. Today, students use laptops, tablets, and smart phones in order to increase engagement (Kim and Chang, 2010; Cheung and Slavin, 2013; Often, 2011).

Technology and Achievement

The changing United States population has also allowed technology to take on a major role in American schools (Lei, 2010). Kim and Chang (2010) found that technology could assist both students with special needs and those who speak English as a second (or other) language in overcoming learning barriers. Delen and Okan Bulut (2011) also studied the impact of technology on achievement, specifically mathematics and science, and found that at-home use of technology increased achievement, and their study showed positive implications for closing the achievement gap that exists between students who are classified as economically disadvantaged and those students who are not. Even with the aforementioned studies, the use of technology is not uniform across the United States (Often, 2011). Beck-Hill & Yigal (2012) also conducted an experimental study on the impact of technology on mathematics achievement. The study compared study groups who received a mixture of traditional lessons and those, which included technology, and a control group who received instruction only using traditional methods. The findings showed that while each of the groups made gains, the gains of the research group were significantly larger than those of the control group, giving credence to the idea that technology enhances students' achievement. It is also important to note that un-excused absences decreased for those students in the research group, suggesting that the technology may have increased student motivation.

As is the case with most areas of research, there are studies that are less supportive; in this particular case, some studies discourage using technology in order to encourage student achievement. For example, Tamim, Bernard, Borokhovsk, Abrami, and Schmid (2011) found that technology alone does not have a positive impact on student achievement. The study concluded that in order for students to benefit, teachers and other instructional personnel must have access to technological resources and proper training. Similarly, Cheung and Slavin (2013) found that technology had only a modest positive impact on student achievement. The researchers examined a total of 74 studies, with a total of 56,886 students in grade K1. While the findings were "consistent with the more recent reviews, the findings suggest that educational technology applications generally produced a positive, though modest, effect (ES = +0.15) in comparison to traditional methods" (p. 88). The work of Cheung and Slavin is encouraging as it suggests that technology is positive, but not a complete solution. For this reason, music and other learning motivators must still be considered as part of the educational system.

Conclusions

Upon reviewing the literature on the impact of music experiences on mathematics achievement it becomes clear that the research is widely varied. Similar to the research on music's influence on overall academic achievement, some studies show a positive correlation while others point to evidence that there is little to no connection (Jaschke, Effermont, Honing & Scherder, 2013).

According to Johnson D. (2000), aptitude for music is highly related to academic achievement. While the results of Johnson's work have been reported as significant, Johnson's 2000 study used a sample size of just 12 male students. Using a more reliable sample size, Lamar (1989) found a significant positive correlation between reading and music aptitude, as well as a relationship that approached significance between mathematics achievement and aptitude for music.

Rauscher and Zupan (2002) also examined the effects of classroom-based music instruction on both the spatial and temporal reasoning of kindergarten students. Students were randomly assigned to the keyboarding group or the no music group. After four months of music instruction, the kindergarteners who received keyboarding instruction outscored their counterparts; after four more months of instruction or eight total months, the keyboarding group was still outscoring the no music group, and the gap was more significant, compared to that which existed after eight months.

Whitehead (2001) conducted a study that examined the effect of the Orff-Schulwerk music instruction program on middle and high school students. Students were randomly placed into three groups. The full treatment group received 50 minutes of music instruction, five days per week, while the limited treatment group received 50 minutes of music instruction, once a week, and the no treatment group received no music instruction. The results of the study showed that students in the full treatment group had the highest gains in mathematics improvement, followed by the students in the limited treatment group, which made less significant gains. The no treatment group had the lowest gain in the area of mathematics improvement.

Summary

Even though music participation can often be a predictor for achievement in the area of mathematics, the opposite is not true. Drennan (1984) found the combination of mathematics, reading, and IQ scores was not a reliable predictor for musical aptitude. Likewise, Barrett (1993) conducted a study from which found that there was no significant correlation between musical aptitude and academic achievement. The study was conducted using 6-8 year-olds who were all the classified is socio-economically disadvantaged. The work of Hobbs (1985) found that the correlation between musical ability and scholastic aptitude was not statistically significant, and De Vries (2010) indicated that this is a result of the musical and classic aptitude tests measuring very different aspects of cognition.

Hayes (1982) conducted a study consisting of a ten percent random sample of 1,203,400 high school students. Results of the study found that although participation in instrumental music was positively correlated with higher ACT results, it was not among the five most influential contributing variables. The five variables most highly correlated with higher ACT results were: high school grade point average, years of past and planned study in mathematics, years of past and planned study in natural sciences, high school class ranking, and gender. Furthermore, Duke, Flowers, and Wolfe (1997) found that the ability to perform on the piano was unrelated to academic achievement.

Self-determination theory suggests that when students like what they are doing and feel that it is worthwhile, they will then self-engage. However, student engagement remains a problem and using music to teach mathematics can be part of the solution because students engage in curricular activities when they are stimulated by environmental factors and interactive activities (Dogan-Temur, 2007; Jang, 2008; Zepke & Leach, 2010). Music can positively affect the environment, acting as a catalyst for student engagement and leading to the learning and retention of mathematical skills and concepts.

Brain research adds more credence to that notion that music is a viable part of the curriculum, with inherent implications for teaching and learning mathematics. A link between music and mathematics is present, as both are processed in the prefrontal cortex and the parietal lobe of the brain. Many believe that because of this connection, music can strengthen the brain's ability to think mathematically. Furthermore, using music in the mathematics classroom may also keep math-related synapses active and avoid their elimination during synaptic pruning. Self-determination theory, multiple intelligence theory, a strong connection stretching back to Pythagoras' time, as well as brain research, come together to illuminate the inherent benefit and logicality of using music in the mathematics classroom. Music becomes even more beneficial when one considers its inherent motivational aspects (Bobis, Anderson, Martin, & Way, 2011; Dogan-Temur, 2007; Dotterer & Lowe, 2011; Jang, 2008; Matiti, 2013; Wang & Holcombe, 2010; Zepke & Leach, 2010).

CHAPTER THREE: METHODOLOGY

The purpose of this causal comparative study is to test the theories of self-determination, multiple intelligence, Maslow's Hierarchy of Needs and brain research in order to examine the impact of non-band music participation on mathematics achievement – after controlling for student aptitude and participation in band for 6th grade students at a mid-sized, central Virginia middle school (An, Capraro & Tillman, 2013; Covino, 2002; Deci & Ryan, 2000; Gardner, 2003; Maslow, 1943; Southgate & Roscgino, 2009). This chapter outlines the participants, setting, applied instrumentation, data collection, and data analysis procedures. The chapter further defines the independent and dependent variables; it also explains instrument validity and reliability levels. The main research question for this study is: does participation in non-band music impact the mathematics achievement of sixth grade students? It was hypothesized that participation in non-band music would have a positive impact.

Research Design

This research study employed a causal comparative design. This design was chosen because the interaction between the independent variable (participation in non-band music classes) and the dependent variable (mathematics achievement) has already occurred. Non-experimental research designs are used when experimentation is not possible or undesirable, as was the case with this study (Creswell, 2013; Gall, Gall, & Borg, 2007). For the purposes of this research, archival data from the 2013-2014 school year were used; hence, permission to conduct a study was needed from a Central Virginia county instead of individual participants. Upon completion of a county IRB application and subsequent review, permission to conduct the study was granted.

Research Questions and Null Hypotheses

Research Questions

The research questions guiding the causal comparative study were:

RQ1: Is there a difference between the mathematics achievements of 6^{th} grade mathematics students based on non-band music participation status?

RQ2: Is there a difference between the mathematics achievements of 6^{th} grade males based on non-band music participation status?

RQ3: Is there a difference between the mathematics achievements of 6^{th} grade females based on non-band music participation status?

Null Hypotheses

The research hypotheses guiding the causal comparative study were:

Null Hypothesis 1: There is no difference between the mathematics achievement of 6^{th} grade mathematics students who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP).

Null Hypothesis 2: There is no difference between the mathematics achievement of 6^{th} grade mathematics males who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP).

Null Hypothesis 3: There is no difference between the mathematics achievement of 6^{th} grade mathematics females who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP).

Participants

Using convenience sampling, a population for the study was identified by the researcher. In order to conduct substantive ex-post facto, causal comparative research, sample sizes of at least thirty per subgroup were recommended by Creswell (2013). The population for this study consists of 765 of the 957 6^{th} grade, middle school students in one central Virginia school district. At the time that the spring NWEA mathematics MAP test was given, all students ranged from 11 to 13 years of age.

Approximately 60% of the total 6^{th} grade population participated in the study, as some sixth graders were omitted based on mathematics course placement. In the Central Virginia public school district where the study takes place, sixth grade mathematics students are divided into three groups based on their mathematics class. Students in standard level classes study sixth grade material, as outlined by the Virginia Standards of Learning. Students in advanced level mathematics classes study sixth and seventh grade material. Students in honors level mathematics classes study all sixth, seventh, and eighth grade material, in order to enroll in algebra in the seventh grade. The honors-level mathematics students were excluded from the sample, as they tend to have a high propensity for mathematics, skewing their academic achievement scores. The removal of this subset of students helped to control the extraneous variable of mathematics aptitude across the sample. Students from the standard and advanced level mathematics classes are further divided into three groups: a) students who have taken one or more semesters of instrumental music class (e.g., band), b) students who have taken one or more semester of vocal music class, and c) students who have not participated in music class. For the purposes of this study, students who participated in instrumental music classes were excluded because a nationwide analysis of research by Elpus (2013) suggests that students in instrumental music classes outperform other groups as a result of selection bias.

Setting

All participants in the study were from one Central Virginia county, which will be referred to from this point on by the pseudonym CVC Public Schools. All sixth-grade middle school students in CVC attend one of the following middle schools: MSA, MSB, MSC, MSD, MSE, or MSF. Students who attend MSF, will not be included in the study because those students attend an art-infused charter school and do not take music classes of any kind. Additionally, the researcher has a conflicting interest at one of the middle schools. Demographics for the four remaining schools vary widely, as shown in Table 1. Since the data used in this study was ex-post facto, all data collection took place in the CVC office building, under the direction office personnel.

Table 1. Demographics of participating middle schools in CVC.

Demographics	**MSA**	**MSB**	**MSC**	**MSD**
Total Enrollment	773	579	609	402
Male	47.7%	50.6%	48.6%	53.5%
Female	52.3%	49.4%	51.4%	46.5%
Black	4.0%	21.8%	7.6%	13.9%
Hispanic	3.8%	12.1%	4.8%	6.2%
White	85%	52.5%	74.9%	73.9%
Limited English Proficiency	1.8%	13.3%	2.6%	2.2%
Disadvantaged	11.3%	40.4%	13.0%	39.8%
Students with Disabilities	8.3%	15.2%	8.0%	13.2%
Gifted	15.1%	12.8%	14.3%	12.9%

Instrumentation

The Northwest Education Association's (NWEA) Measures of Academic Progress (MAP) test was used to assess mathematics achievement. The Northwest Evaluation Association's (2011) Measures of Academic Progress test is a nationally normed test used to measure academic progress in the areas of reading, writing, science, and mathematics (Cronin, Dhalin, Durant, & Xiang, 2010). The test is used to glean a wealth of information including student achievement within different domains. Data from MAP testing is a widely accepted growth measure and were used to measure the achievement of the student groups. The mathematics MAP test focuses on seven different domains of the genre: a) number sense/ number systems b) estimation and computation c) algebra d) geometry e) measurement f) statistics and probability and g) problem solving, reasoning, and proofs (NWEA, 2012).

The NWEA (2012) published RIT scales for each subject area. The RIT scale is used to measure a student's academic growth over time. Like units on a ruler, the scale is divided into equal intervals – called Rasch Units (RIT) – and is independent of grade level. Through repeated trials, grade-level norms have been established. Mann-Whitney U Tests were used to determine whether or not there are significant differences between those students who participated in non-band music and those who do not.

Reliable instruments must have a reliability level $\geq .80$ (Creswell, 2013; Gall, Gall, & Borg, 2007). Using a Test-Retest model, the reliability of the mathematics MAP test, at the sixth grade level has remained consistent since 1999, ranging from .91-.93; using a Marginal Model, reliability is higher at the .94-.95 level. Validity tests show that there is a .759 correlation between the NWEA Mathematics MAP and the Virginia Standards of Learning. Validity levels are often lower than reliability levels. In this case, the reliability level is largely due to the encompassing nature of the NWEA's MAP test (2012), and it represents a strong relationship between the Virginia Standards of Learning assessment items and the items presented on the MAP test.

Procedures

Because the research is ex-post facto, the impact upon students was minimal; for this reason, the Liberty Institutional Review Board (IRB) granted permission to conduct the study. Upon approval by the Liberty IRB, a request to complete a study was submitted to Central Virginia County. The proposal will include study type, description of potential impact on students, and expressed plans to protect the privacy rights of all parties involved. NWEA - MAP (2012) scores from the 2013-2014 administration, student gender, a code for music participation, and a code for mathematics course placement were released to the researcher using a digital format, to be determined by the county office. In order to protect anonymity, no student names or other identifiers were attached to the data. Data was given to the researcher as a PSPP file, and was then uploaded into SPSS statistics software (version 22), in preparation for thorough analysis.

Data Analysis

The data analysis procedures will follow the model set forth by Gall, Gall, and Borg (2007). A causal comparative research design was used to determine if students' academic progress differed based on whether or not they participated in non-band music. This research design was chosen as it attempts to explicate whether or not causative relationships exist between variables. The first step in examining data in a causal comparative manner is to construct and investigate frequency polygons. Next, the data were analyzed using SPSS 22 in order to create a set of descriptive statistics for each group.

According to Laerd (2014), “The Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed”. It also allows the researcher to compare mean rank scores and examine differences in medians. While a t-test can allows for a similar analysis, it is not an efficient when the data are not normally distributed. The researcher chose to utilize knowledge of normality of distribution assumptions in order to choose between running a Mann-Whitney U or a t-test. The Mann-Whitney U test is better than the t-test for data that are non-normally distributed. Additionally, even though the t-test is considered robust, a Mann-Whitney U was chosen for this research as the differences in group sizes were greater than 1.5 (when comparing smaller to larger). This was the case, with the research data, especially with regards to subsets of students (male and female). Hence, Mann-Whitney U tests were employed in order to compare the mean ranks and medians for groups of students who participated in non-band music and those who did not.

Student MAP scores from Fall 2013 were used in order to ensure that groups are comparable. In order to determine effect size, the researcher will take the difference between the group of students who participated in non-band music classes and those who did not and divide by the standard deviation of the non-band participant student group. This process was repeated in order to determine the effect size for the comparison of males who participated in non-band music and those who did not, as well as females who participated in non-band music and those who did not. For each analysis, an alpha level $<.05$ is acceptable (Gall, Gall, & Borg, 2007). In order to test for each predictor variable, NWEA - MAP test results were examined. Steps were repeated in order to analyze mean differences between subgroups of males and females who participated in non-band music class and those who did not.

Chapter Summary

The purpose of this study is to investigate the impact of non-band music participation on the academic achievement of 6th grade mathematics students, using codes for music participation status and scores the nationally-normed, NWEA - MAP assessment (2012). Mann-Whitney U Tests were used to compare the mean differences of the following groups: a) students who participated in non-band music class and students who did not; b) males who participated in non-band music class and males who did not; and c) females who participated in non-band music class and females who did not.

The researcher made a deliberate attempt to conduct the study in a trustworthy manner. Trustworthiness was achieved through attention to issues impacting both internal and eternal validity. Instrument reliability and validity were addressed by assessing the academic achievement of 6th grade mathematics students, using the nationally normed, NWEA, Mathematics MAP test. Further, the researcher consulted with a team of professionals to ensure that data analysis was conducted in an objective manner. The researcher also made an effort to conduct the study in an ethical manner. These efforts were included: obtaining data without student names; ensuring that data was shared in a responsible manner and disposed of one year after the study, in order to protect the study population; and ensuring that the reporting all data and findings occurred in an accurate and responsible manner.

Chapter four presents the findings from the research study. The findings explore the three research questions. Findings include a preliminary discussion of sample demographics, frequency polygons for each subgroup, sets of descriptive statics, and an analysis of means and standard deviations. A Mann-Whitney U was used to analyze the differences in median scale scores, based on participation status, in non-band music. In addition, the chapter discusses the impact of non-band music participation on the academic achievement of 6th grade mathematics students.

CHAPTER FOUR: RESULTS

The purpose of this study was to examine the impact of non-band music participation on mathematics achievement, by comparing the mean ranks on the Northwest Education Association's Measures of Academic Progress Assessment (2012) for groups of students who participated in non-band music class and those who did not. Additionally, the impact of non-band music participation on mathematics achievement was analyzed based on gender.

Chapter four is divided into four main sections: a) results of the *Mann-Whitney U Test* used to test null hypothesis one, comparing the mean rank for the group of students who participated in non-band music class and those who did not; b) results of the *Mann-Whitney U Test* used to test null hypothesis two, comparing the mean rank for the group of males who participated in non-band music class and males who did not; c) results of the *Mann-Whitney U Test* used to test null hypothesis two, comparing the mean rank for the group of females who participated in non-band music class and females who did not; and d) the chapter summary.

Participants

This study examined whether or not there was a statistical difference in the mean ranks of groups of 6th grade students who participated in non-band music class and those students who did not. The study also examined (1) whether or not there was a statistical difference in the mean ranks of groups of 6th grade males who participated in non-band music class and those students who did not and (2) whether or not there was a statistical difference between females who participated in non-band music class and those who did not.

The study data were given to the researcher with codes for gender (M=male and F=female), Spring MAP scores (MAP score), arts elective classes, and mathematics courses. The data was then prepared for analysis. 756 scores were given to the researcher; of these, 609 cases or 80.56% contained end-of-year mathematics MAP scores. The mean mathematics score for this group was 232.39, as it included scores for all levels of mathematics and all levels of arts participation. Next, MAP scores for students who took honors level (6-8th grade) were removed. This reduced the number of cases from 609 to 385 or 51% of the total. Lastly, the scores were sorted by music participation status, and students who took band were removed. This left a total of 301 student scores, 39.81% of the total scores for 6th graders at the four participating middle schools, and % of the total scores for 6th graders in CVC. There were 986 6th graders enrolled in the CVC during the 2013-2014 school year. Of those students, 482 were female and 504 were male. This means that 685, or 69.47%, of student scores were not used in the study because of middle school exclusion, exclusion based on placement in an honors level math class, or exclusion based on participation in band.

Of the scores that were analyzed, 158 (52.49%) were scores of females while, 143 (57.51%) were scores of males. 79 students (26.24%) participated in non-band music class and 222 (73.76%) did not. 60 (37.97%) female students participated in non-band music class, while 98 (62.03%) did not. 19 (13.29%) male students participated in non-band music and 124 or 86.71% did not.

Results

Three separate analyses were conducted using the data. The first analysis compared the mean ranks of the group of 6th grade students who participated in non-band music class with that of the group of students who did not. The second analysis examined only scores of males and compared the mean ranks of males who participated in non-band music class with those who did not. The third, final analysis examined scores of females and compared the mean ranks for females who participated in non-band music class with the mean rank of those who did not.

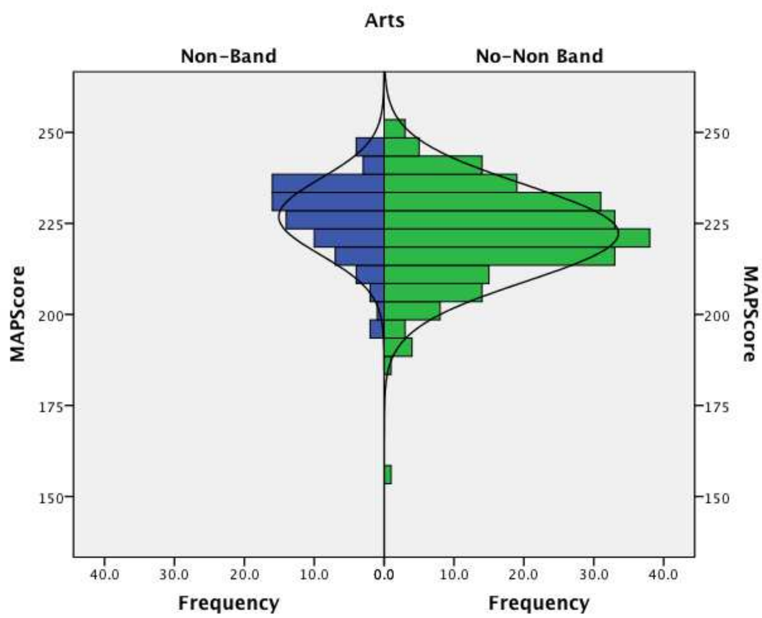
This study used a Mann-Whitney U Test to compare mean ranks for groups. According to Gall, Gall, and Borg (2007), a Mann-Whitney U Test is to be performed when data meet three main prerequisites: a) there is a single independent variable, measured on a continuous scale, b) there is a single independent variable consisting of two, independent groups, c) there are no relationships between the observations of each group, and d) the distribution of scores for each group are different. The researcher determined that the data used for this study met the four aforementioned criteria, and therefore, a Mann-Whitney U Test was chosen.

The IBM Statistical Package for the Social Sciences (SPSS) was used to test a fourth assumption in order to determine whether or not Mann-Whitney U Test was an appropriate method for testing each null hypothesis. The assumptions was that the distribution of data was different between the two groups bring compared. The data met this assumption, and the Mann-Whitney U Test was used as the method for comparing the mean ranks for each group (Gall, Gall, and Borg, 2007). This study employed an ex-post facto causal comparative design, which used NWEA mathematics MAP scores for students who participated in non-band music class and those who did not. As it was the most updated version available, IBM SPSS version 22 was used for all data analysis.

Research Hypothesis #1

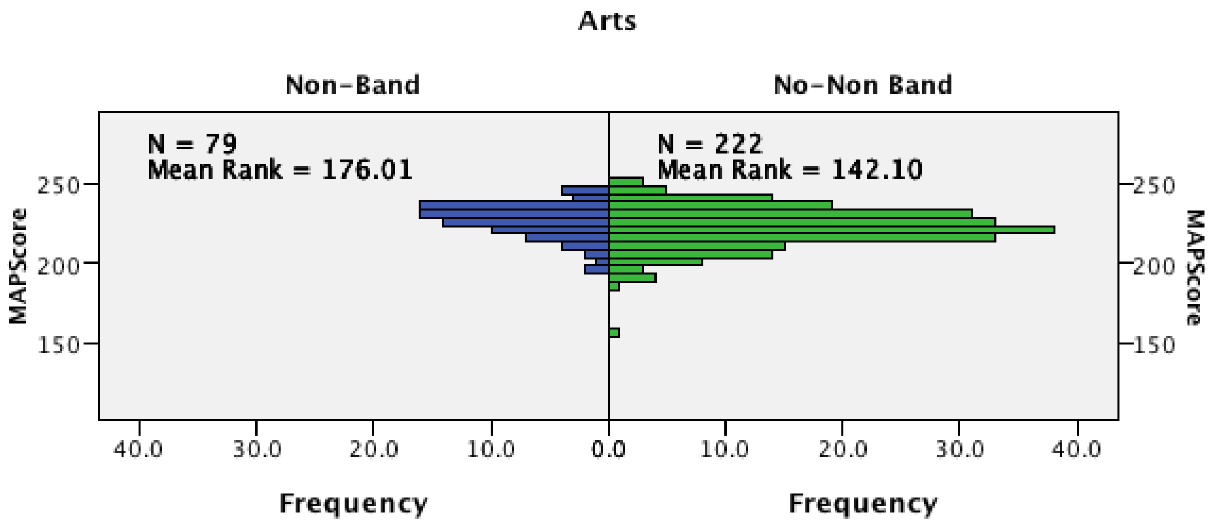
There is no difference between the mathematics achievement of 6th grade mathematics students who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP). This first hypothesis focuses on the overall scores of the group of students who participated in non-band music class and those who did not by comparing the arts scores data between the two groups. The two groups are considered to be statistically separate from one another, and with the exception on one outlier score, they did not have any extreme deviations from normality, as shown in Figure 1

Figure #1. Mathematics MAP scores for all students by arts group (non-band and no non-band).



A Mann-Whitney U test was run to determine if there were differences in the NWEA MAP scores between the group of students who participated in non-band music and the group of students who did not. Distributions of the scores were similar, as assessed by visual inspection of a histogram. MAP scores for the group of students who participated in non-band music (mean rank = 176.01) and the group of students who did not participate in non-band music (mean rank = 142.10) were different, $U = 6,793.5$, $z = -2.927$, $p = .003$. The group of students who participated in non-band music had a higher mean rank and a higher median score (228) than the group of students who did not participate in non-band music class (median =222). It is important to note the p-value of .003 suggests a very low probability of rejecting the null hypothesis when it is actually true.

Figure 2. Independent samples Mann-Whitney U Test results for the group of students who participated in non-band music class and the group of students who did not.

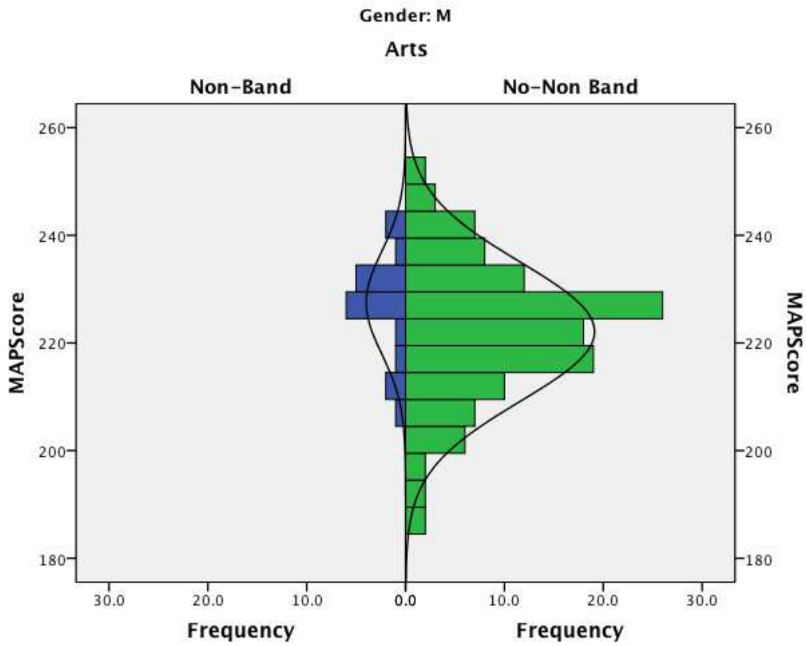


The significance totals of the dependent variable data display a .003 result indicating a $p < 0.05$. Table 2 displays the results of the Mann-Whitney U Test on the NWEA Mathematics Map scores for both the group of students who participated in non-band music and the group of students who did not. Based on the results, the researcher rejected Null-Hypothesis #1.

Research Hypothesis #2

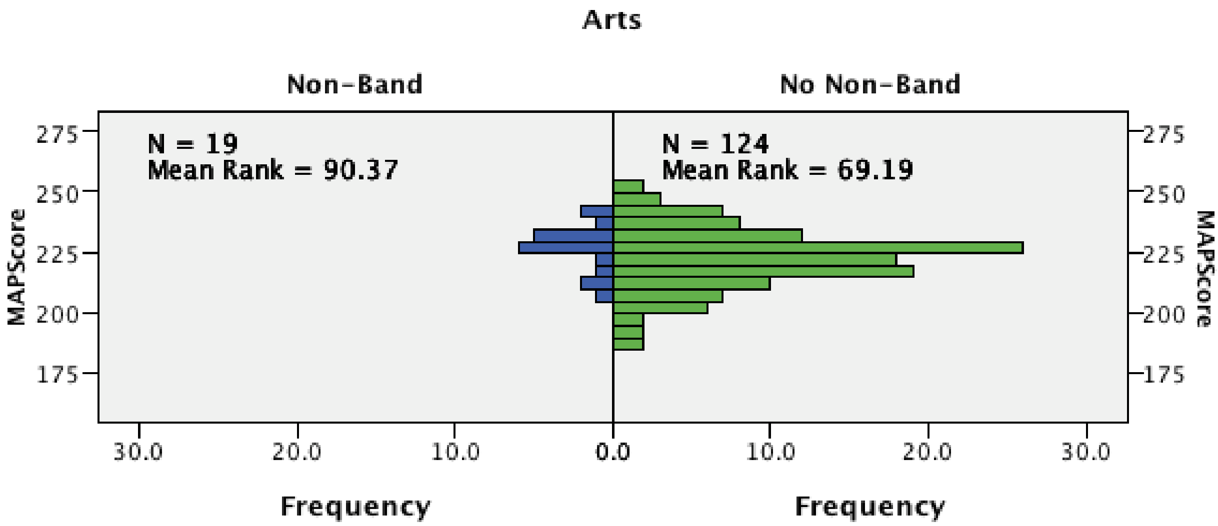
There is no difference between the mathematics achievement of 6th grade males who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP). The second research hypothesis focuses on the scores between the group of male students who participated in non-band music class and those who did not by comparing the dependent variable data between the two groups. The two groups are considered to be statistically separate from one another, and with the exception on one outlier score, they do not have any extreme deviations from normality, as shown in Figure 3.

Figure #3. Mathematics MAP scores for males by arts group (non-band and no non-band).



A Mann-Whitney U test was run to determine if there were differences in achievement scores between the group of students who participated in non-band music and the group of students who did not. Distributions of NWEA Mathematics MAP scores for the two groups of males were not similar, as assessed by visual inspection. Mathematics achievement scores for the group of students who participated in non-band music (mean rank = 90.37) and the group of students who did not participate in non-band music (mean rank = 69.19) were different, $U = 829$, $z = -2.077$, $p = .038$. The group of male students who participated in non-band music had a higher mean rank and a higher median score (229) than the group of students who did not participate in non-band music class (median =222.5). When comparing the group of males who participated in non-band music and the group of males who did not, the p=value of .038 is higher than the .003 p-value of the Mann-Whitney U for the group of all students who participated in non-band music and the group of students who did not..

Figure 4 Independent samples Mann-Whitney U Test results for the group of males who participated in non-band music class and the group of males who did not.

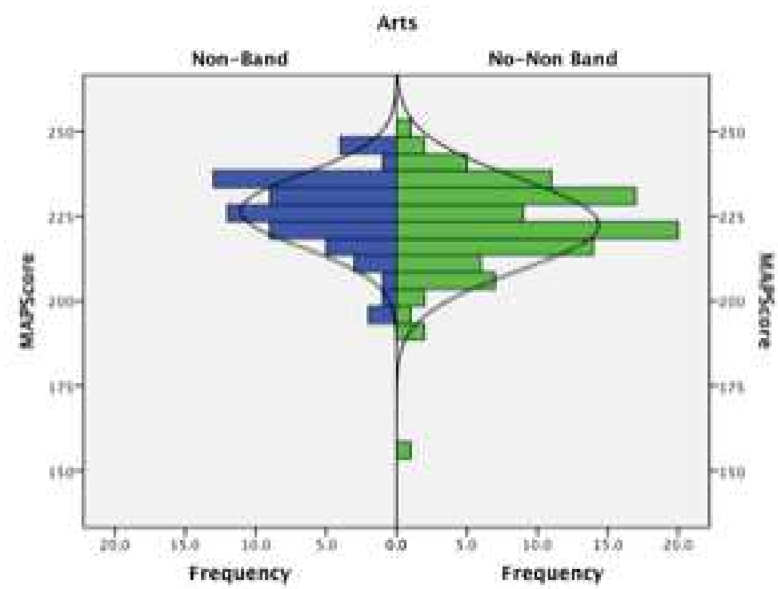


The significance totals of the dependent variable data display a .038 result indicating a $p < 0.05$. Figure 4 displays the results of the Mann-Whitney U Test on the NWEA Mathematics Map scores for both the group of male students who participated in non-band music and the group of male students who did not. Based on the results the researcher rejected Null-Hypothesis #2.

Research Hypothesis #3

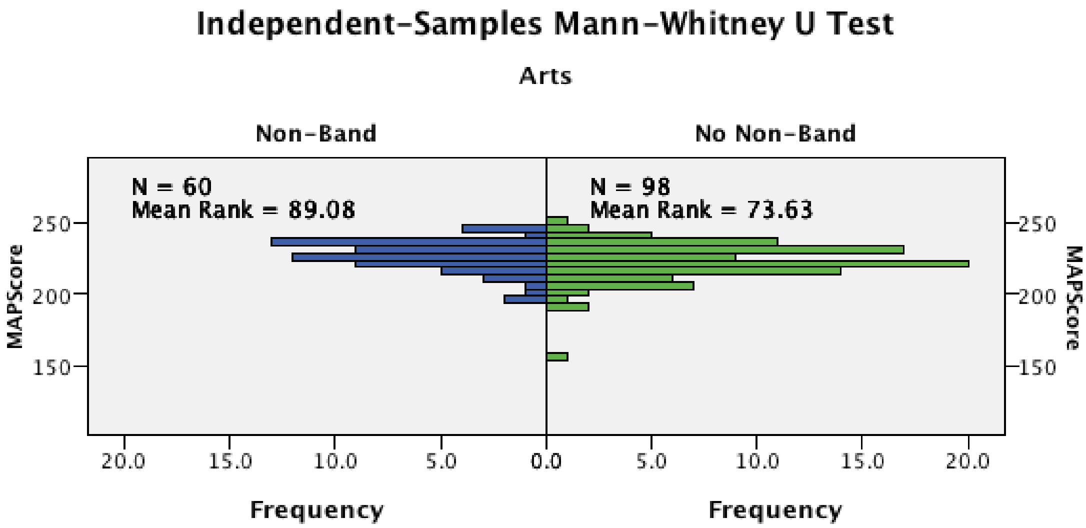
There is no difference between the mathematics achievement of 6th grade females who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP). The second research hypothesis focuses on the scores between the groups of female students who participated in non-band music class and those who did not by comparing the dependent variable data between the two groups. The two groups are considered to be statistically separate from one another, and with the exception on one outlier score, they do not have any extreme deviations from normality, as shown in Figure 3.

Figure #5. Mathematics MAP scores for males by arts group (non-band and no non-band).



A Mann-Whitney U test was run to determine if there were differences in achievement scores between the group of female students who participated in non-band music and the group of female students who did not. Distributions of NWEA Mathematics MAP scores for the two groups of females were not similar, as assessed by visual inspection. Mathematics achievement scores for the group of female students who participated in non-band music (mean rank = 89.08) and the group of female students who did not participate in non-band music (mean rank = 73.38) were different, U = 2,365, z = -1.970, p =.049. The group of female students who participated in non-band music had a higher mean rank and a higher median score (227) than the group of female students who did not participate in non-band music class (median =222). When comparing the group of females who participated in non-band music and the group of males who did not, the p=value of .048 is higher than the .003 p-value of the Mann-Whitney U for the group of all students who participated in non-band music and the group of students who did not..

Figure 6. Independent samples Mann-Whitney U Test results for the group of females who participated in non-band music class and the group of females who did not.



The significance totals of the dependent variable data display a .038 result, indicating a $p < 0.05$. Figure 3 displays the results of the Mann-Whitney U Test on the NWEA Mathematics Map scores for both the group of female students who participated in non-band music and the group of female students who did not. Based on the results, the researcher rejected Null-Hypothesis #3.

Summary

The results from the Mann-Whitney U that the mean rank score for the group of 6th grade students who participated in non-band music was higher than the mean rank score of the group of students who did not participate in non-band music. The results for were the same for groups of males and groups of females, finding that the Mann-Whitney showed that students in each non-band music group scored better than the group who did take a non-band music elective.

Presented in Chapter 5 is a summary of study findings, review of methodology, and a discussion of the procedures and results from the study. Several limitations to the study are considered, and implications are discussed. Finally, recommendations for future research of music and its impact of mathematics are made.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Chapter five provides an overall study summary and an overview of the results of this ex-post facto, causal comparative research. The following sections are included in chapter five: a) summary of findings b) review of methodology, c) discussion, d) limitations of the study, e) study implications, and f) recommendations for further research.

Summary of Findings

The primary, independent variable for this study was defined as participation status in non-band music class. The dependent variable was academic achievement in the area of mathematics. The confounding variables of student aptitude, and teacher styles were controlled. Mann-Whitney U Tests were used in order to determine if there were difference between the mean rank scores on the NWEA Mathematics MAP scores for the group of students who participate in non-band music class and the group of students who do not. The results of this study showed that there was a difference between the mathematics achievements of 6th grade students based on non-band music participation. These differences all showed that mean ranks for students, males, and females were higher when the students participated in non-band music class.

The results of this study showed that during the 2013-2014 school year, the group of 6th grade students in CVC who participated in non-band music class had a higher mean rank than the group of students who did not participate in non-band music class. The expected results were that students who participated in non-band music class would have a higher mean rank score on the NWEA Mathematics MAP test than those students who did not participate. The researcher also investigated the impact of non-band music participation on groups of males and groups of females.

The first research question investigated whether there was a significant difference in the mean ranks of groups of 6th grade students based on participation in non-band music class. The results revealed that students who participated in non-band music class one or two times during their 6th grade year had a higher mean rank than the group of students who did not take any non-band music classes. There are several different factors that can contribute to NWEA Mathematics MAP score of one student. However, since the researcher took steps to control extraneous variables, non-band music participation may be the cause of the difference in mean ranks.

The second research question investigated whether there was a significant difference in the mean ranks of groups of 6th grade males based on participation in non-band music class. The results revealed that males who participated in non-band music class one or two times during their 6th grade year had a higher mean rank than the group of males who did not take any non-band music classes. It is important to note that only 19 (13.29%) of males participated in non-band music class, while 124 (86.71%) did not participate in non-band music class. Participation in non-band music class is a collective decision between student, counselor, and parents/guardians.

The third research question investigated whether there was a significant difference in the mean ranks of groups of 6th grade females based on participation in non-band music class. The results revealed that females who participated in non-band music class one or two times during their 6th grade year had a higher mean rank than the group of females who did not take any non-band music classes. More girls participated in non-band music class than those who choose not to participate. 98 (62.03%) of females participated in non-band music class, while 60 (37.97%) did not participate in non-band music class.

The overall results of this study help to provide a framework for further discussion and future research. This study supports the assertion that participation is non-band music class has a positive impact of the mathematics achievement of 6th grade students, as measured by the NWEA MAP test (2012). The study found that the group of students who participated in non-band music class had a significantly higher mean rank when compared to the group of students who did not participate.

Review of Methodology

The purpose of this quantitative, causal comparative study was to test the theories of self-determination, multiple intelligence, Maslow's hierarchy of needs and brain research to examine the impact of participation in non-band music on academic mathematics achievement, after controlling for student aptitude and participation in instrumental music for 6th grade mathematics students at a mid-sized, central Virginia middle school.

The data collected came from one NWEA Mathematics MAP test scores for 6th grade students from four middle schools in one Central Virginia county. Mean ranks for students who took a compacted 6-8th grade mathematics class and those who attended a charter school were not included in the data. Additionally, scores for students at the middle school where the researcher works were removed. The remaining scores were used to test three null hypotheses. The first was the following: there is no difference between the mathematics achievement of 6th grade mathematics students who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association's (2011) Mathematics Measures of Adequate Progress Assessment (MAP). The second and third hypotheses tested to see if there were significant differences in the mean ranks of males and females, respectively, based on non-band music participation classes. The data for each group were analyzed by constructing frequency polygons, developing sets of descriptive statistics, and examining the means and standard deviations. Subsequently, Mann-Whitney U Tests were used to compare means.

Discussion

As stated in chapter two, the purpose of this quantitative, causal comparative study was to test the theories of self-determination, multiple intelligence, Maslow's hierarchy of needs and brain research to examine the impact of participation in non-band music on academic mathematics achievement, after controlling for student aptitude and participation in instrumental music for 6th grade mathematics students at a mid-sized, Central Virginia middle school. The independent variable was defined as participation status in non-band music class. The dependent variable was defined as academic achievement in the area of mathematics. The confounding variables of student aptitude and teacher styles were statistically controlled.

While the 2010 ESEA legislation was enacted to address nationwide about academic achievement, the legislation has become one of the most divisive of the century. The law outlines a focus on the achievement of all students in the core content areas, with an intense focus on reading and mathematics (NCLB; U.S. Department of Education [USDOE], 2010). However, mathematics achievement continues to be a major area of concern for lawmakers, parents, and educators alike (Wagner, 2008). The mathematics achievement of American students has not gotten any better. It is unclear exactly what is causing the stagnation, but it is evident that the No Child Left Behind (NCLB) legislation is not helping to bring America's children up to the level of other developed countries around the world (Wagner, 2008). Henwood and Featherstone (2013) purport that the law does not meet it goals because of the manner in which it places a concentrated focus on reading and mathematics, while largely dismissing the arts, history, music, and science. This quantitative study sought to investigate the impact of non-band music participation on the academic achievement of 6th grade mathematics students. Self-determination theory, multiple intelligence theory, Maslow's Hierarchy of Needs, and brain research provide a theoretical framework (Allcock & Hulme, 2010; Covino, 2002; Deci & Ryan, 2008; Jang, 2008; Ryan & Deci, 2000; Shaw, 2003). This research sought to address a primary gap in the literature, represented by a lack of information on the impact of non-band music participation at the middle school level upon student achievement.

Theoretical Practices for Engagement, Motivation, and Academic Performance

Engagement, motivation, and academic achievement are intrinsically linked. Each one of the three impacts the others. According to Mora (2011), during the middle school years, students are in the process of building identity. Spires et al. (2008) also asserts that the act of collaboration is of utmost importance during the middle school years, as it helps students to find their place. Furthermore, Turner, Warzon, and Christensen (2011) assert that belongingness can be fostered through activities that require students to work together. Participation in non-band music is one such activity.

When students take a music class of any kind, they are participating in an activity that helps them become part of a whole. This research suggests that this is not just the case with band, but that non-band music class can have a positive impact on academic achievement; therefore, it can be seen as an important in trying to increase motivation, academic achievement and engagement. Another important point that Spires et al. (2008) makes is that students are individuals and should be seen as such. Therefore, non-band music participation should not be seen as positive for every student. However, it may be positive for some.

Tackling Boredom

This study suggests that students who participate in non-band music class achieve at higher levels than their peers who do not participate in music. These findings are supported by the work of many who have found music to be an effective tool for tackling boredom, and breaking the cycle of low motivation, engagement, and achievement (Abdallah, 2008; Gorey, 2009; and Spires *et al.* 2008). Middle school students across the United States report that school is boring (Mora, 2011). Much of this is the result of middle school experience. The middle school experience is one that requires a heavy focus on reading and mathematics. This often means that teachers and other instructional personnel feel as if they must choose between having an engaging lesson, a motivational lesson, or one that teaches students what they need to know.

The middle school experience should not be one of engagement, motivation, or achievement, but all three (Donner and Shockley, 2010). As teachers learn to instruct in a manner that meets the engagement needs of their student's motivation and academic achievement will follow. This includes creating culturally responsive classrooms (Abdallah, 2008; Gorey, 2009; and Spires *et al.* 2008); these are classrooms that go beyond celebrations of feasts and festivals to honor the individuality of each and every student in the classroom. Instructional personnel do not always have autonomy over what should be taught, but they can control the methods used for teaching. To reiterate, this study suggests that students who participate in non-band music class achieve at higher levels than their peers who do not participate in music. These findings are supported by the work of many who have found music to be an effective tool for tackling boredom, and breaking the cycle of low motivation, engagement, and achievement (Abdallah, 2008; Gorey, 2009; and Spires *et al.* 2008).

Culturally Responsive Classrooms

This study is now one more that supports the idea that when students are taught in a culturally responsive manner, they achieve at higher levels. Some believe that this is because students start to feel better about themselves (Parker, 2010; Sparrow and Hurst, 2010; Spires et. al, 2010). Further, when students do not have cultural connections at school conflict may arise as the cycle of low motivation, low levels of engagement, and poor academic achievement is set into motion. During the middle school years, students decide how they want to navigate the school experience, and it is of utmost importance that they can connect. Rapp (2009) purports that students can be turned off from school if they are not allowed to learn using modalities that lead to success. Middle and high school teachers may find it difficult to bring many learning activities into the classroom, but the presence of a diverse group of elective classes, including non-band music, can help to create a cohesive learning experience (Rickard, Vasquez, Murphy, Gill, & Touksati, 2011; Sparrow and Hurst, 2010).

Culture is a construct, which arises early in the school experience. Colbert (2010) states that each person's culture is constructed out of a variety of characteristics. While these characteristics include race, ethnicity, and gender, they also include communication, language, appearance, and much more. There is also a sense of status, age, relationships, mental processing, and learning tendencies. Each individual is different. Non-band music participation may be useful for a student or group of students, but it will not have the same impact on all middle school students.

Implications

The results from this study clearly establish that 6th grade students who participate in non-band music class outperform 6th grade students who do not participate in music. MAP scores for the group of students who participated in non-band music (mean rank = 176.01) and the group of students who did not participate in non-band music (mean rank = 142.10) were different, $U = 6{,}793.5$, $z = -2.927$, $p = .003$. The group of students who participated in non-band music had a higher mean rank and a higher median score (228) than the group of students who did not participate in non-band music class (median =222). These results are statistically robust

($p<.05$). The findings support the assertions that 6th grade, mathematics students, in one, Central Virginia school division, who participate in non-band music performed better on the NWEA MAP test, that their peers who did not participate. Findings were also true for gender subsets. If the participants in this study are representative of their peers across subjects, other secondary grade levels, and areas, than the findings of this study are far reaching.

Challenging fiscal times and the ambiguous inclusion of the arts in United States legislation has led to the demise of music programs across the country. These programs are being cut or dismantled in order to increase the availability of resources for reading and mathematics instruction (Marshall, 2014). However, American children still lag behind those of other developed nations (Wagner, 2008). It is postulated that the loss of music programs may actually be detrimental to students, as the importance of music in the educational environment may act to engage students, thereby increasing motivation and academic achievement (Parker, 2010; Spires et al, 2008). A proposed remedy to the aforementioned problem is one that will increase achievement in reading and mathematics, while maintaining inclusion of the arts. The arts are important as they serve to motivate students. In particular, music may serve as an inspiring activity while contributing to the acquisition of mathematical knowledge (An, Ma, & Caparo, 2009; Hallam, 2010; Helmrich, 2010; Legg, 2009; Southgate & Roscigno, 2009). This study suggests that music can and should be used as a viable part of the middle school curriculum, as students who participate in non-band music outperform those who do not participate in music class.

This research is supported by Maslow's Hierarchy of Needs, the theory of self-determination, multiple intelligence theory, and brain research, however, educational theory does not directly correlate to educational practice. Shilling (2003) states that music is a learning tool that every child has in her or his tool belt; however, it is a tool that goes largely unused by educators. Currently, music is used as a teaching method at the elementary school level, but this practice is all but abandoned in middle school. In fact, students who attend secondary schools are rarely afforded the opportunity to use music as a learning tool. This research, and research like it mean that music should be considered as a teaching method at the secondary level.

The work of Shilling is striking because it focuses on the connections between music and fractals, but Shilling points out that this connection is not what leads to student learning. It is the enchantment with music that leads to engagement, motivation, and academic achievement. This research study suggests that there may be more to Shillings argument; not only are students engaged and motivated through the use of music, but participation in a non-band music class can positively impact mathematics achievement, lending more credence the idea that music must be tapped as a resource.

Pythagoras purported that math is music and music is math, and when engaging one discipline or the other, one is actually engaging both (An, Ma, and Capraro, 2009). This may be the reason why a non-band music class was found to have a positive impact on mathematics achievement. Box and Watson (2010) support this idea, stating that older students may begin to question whether they are learning music or math. This study suggests that when middle school students learn math and music at the same time, the results are significantly better than if the students are not learning music.

This study suggests that the use of music as part of a viable middle school curriculum is valid. Middle school is a trying time in the life of a child. Furthermore, lack of instructional practices that are meaningful and motivating to children can lead to low educational achievement and other problems. This study suggests that music can be used as an educational tool to motivate students, and supports brain research that suggests music is imperative at the middle school level (Covino, 2002). Not only can music positively impact mathematics achievement, but it can motivate students, and when students are motivated, levels of engagement increase and levels of conflict decrease (Parker, 2010; Spires *et.al,* 2008).

Limitations

There are some limitations associated with this research study. The limitations of the study are as follows: a) the population for which this research is significant is small and unique, as the participants are from a singular school division, in a singular state, so results may not be generalizable across other populations; b) efforts to control the confounding variable of student ability are based on mathematics course placement, rather than aptitude measures; c) the sample will only include those students who took both the fall and spring versions of the NWEA-MAP (2012) assessment, so while this strengthens validity, it diminishes the sample size; and d) the use of convenience sampling threatens the ability to generalize the findings of the study to the population.

The delimitations of this study are as follows: a) in order to maintain the anonymity all student scores, the researcher nor the county office personnel sorted the researchers own students scores from the batch; and b) county office personnel provided all scores for the purposes of research. This increases the probability of the Hawthorne effect (Gall, Gall, and Borg, 2007). While limitations and delimitations compromise external validity, efforts have been made to fortify internal validity. This allows the research to act as an important step in filling the gap that exists in regard to the impact of non-band music participation.

Recommendations for Future Research

This study attempts to show the impact of non-band music participation on the mathematics achievement of 6th grade students. Future research on the topic should include studies that focus on whether or not non-band music participation or selection bias impacts mathematics achievement. Research should examine the impact of high stakes testing on music educations courses, and academic achievement, as well as the impact of non-band music on the mathematics achievement of middle school students who receive special education services. Further, this study did not disaggregate data based on ethnicity or socio-economic status, discovering how non-band music impacts different groups based on these criteria would be valuable.

Educational research should help to guide educational practice and decision-making. Therefore, it is recommended that further research include examining the motivation, engagement, and academic achievement of students who receive music different levels and types of music instruction and those who do not, as well as examination of the impact of other informal methods of music exposure, like online streaming services, music on the school bus, etc. These studies can lead to further improvements to the educational system, in the United States.

Future studies should also seek to learn more information about whether or not band class is beneficial, or if the connection between those students who participate is simply a result of selection bias. This can be tackled by conducting studies that work expand both the number of participants – teachers, students, as well as the grade range of students of studies conducted by researchers, such as An, Ma, and Capraro, and Tillman (2013) and Elpus (2013). Further research might also seek to address the gap in the literature that exists with regards to the use of music in secondary language arts, science, and social studies classrooms. If there is a positive impact during the early elementary school years, there might also be a positive impact in middle or high school. It is important to note that the research should include lessons, classes, or whole programs that are cross-curricular and music-infused as opposed to singular music-based lessons like using fractions to read music, as is common at the secondary level.

It is important to examine the impact of music on academics using test scores, and it may also prove useful to study the reverse. Future research should examine how high-stakes testing is impacting music and other arts programs? Baker (2012) conducted a study that found that eighth grade students who participated in music class (instrumental or choral) had significantly higher mean scores than those who were not enrolled in music. Baker (2012) further states that many students are denied the opportunity to participate in music class because of high-stakes testing. When students fail high-stakes tests then they take remedial math and reading classes instead of music. Future research should examine the impact of remedial classes on the overall academic achievement of students, to examine whether or not they are beneficial.

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APPENDIX A

Liberty University IRB Approval Letter

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

January 29, 2015

Sherica Denise Jones-Lewis
IRB Exemption 2007.012915: The Impact of Non-Band Music Participation on the Mathematics Achievement of 6th Grade Students

Dear Sherica,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

> (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

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