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How Infusing Music Into Elementary Mathematics Curriculum Affects Students' Learning and Engagement

Caitlin Riebe

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by

Caitlin Riebe

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Hamline University

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Capstone Project Facilitator: Jana Lo Bello Miller
Content Expert: Jeff Fink
Content Expert: Anne Norsted
Content Expert: Sandy Yunker

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CHAPTER ONE

Research Rationale and Context

Introduction

Students today are faced with the challenge of learning academic content in the midst of a standardized-test driven society. Children who don't learn well via traditional instructional methods are often left behind when standardized test season comes around. Teachers are faced with the task of teaching a plethora of state and national academic standards to a room full of students that possess varying levels of skills, needs, and capabilities. Although they may be aware of how multiple intelligences and various learning styles affect their teaching and their students' learning, teachers are often without resources or ample time to differentiate academic content for their students in a way that is accessible to a group of diverse learners.

In a world where test scores generate funding supports, schools and districts are finding themselves having to cut specialists and extra enrichment activities that don't have a direct correlation with the content examined within standardized tests. This means that many students in the United States only have gym, music, and art classes a few times per week (Long, 2017). What would happen if students were taught within a framework of applying their existing strengths, talents, and interests to academic content? Interdisciplinary work is something that is often highly regarded in theory but is seldom utilized in classrooms today (Still & Bobis, 2005). A strong relationship between mathematics and music exists, but this relationship could certainly be emphasized and utilized better in the classroom (An et al., 2013). This study aims to answer the research

question: *How does infusing music into elementary mathematics curriculum affect student learning and engagement?*

Chapter One of this capstone offers an overview of my personal and professional experiences related to the topic at hand. First, I discuss my own personal experiences with music and mathematics throughout the course of my life. Although I have always loved music, my opinion of math has changed drastically since I was in elementary school; I went from once despising math in all forms, to now teaching it to my second grade students with enthusiasm, excitement, and passion. Next, I describe the rationale for my project. My project goal is to create a revised curriculum that integrates music with math so that students are able to engage with the content more deeply and use mnemonic devices, like songs, to help them remember concepts that may be difficult to grasp at first.

Musical Background

My parents often fondly proclaim that I started singing before I could speak. I would entertain relatives and friends who would come over to our home for events with hits such as “She’ll Be Comin’ ‘Round the Mountain” and “Oh, Susannah,” sometimes inventing my own lyrics when I couldn’t recall the ones that the artist had written. This love for music has continued throughout my life. When I was just 5 years old, my parents had me audition for a community theater summer musical. Although I can’t remember much from back then, I believe that this spurred my interest in theater and strengthened my love for music.

I started playing flute in fourth grade and always looked forward to the weekly music lessons. My elementary school general music teachers became my favorite people to see during the day and they nurtured my musical interests and talents from the beginning. Although many of my elementary peers hated music class, I didn't let that deter me from my interest. In sixth grade, I was invited to participate in the all-district honors choir. I fondly remember the feeling of joy I felt at our practices, being surrounded by kids like myself who had such an aptitude for music rather than an apathetic attitude like my peers at school. In middle school, I participated in morning choir before school, theater after school, and band during the school day. In high school, I had to make the choice between band and choir for my scheduling purposes, and although it was a tough one, I ultimately chose to pursue choir. I participated in extracurricular choirs, honors choirs, and musical theater as well as plays. I taught myself the ukulele and my best friend and I would often spend hours figuring out arrangements to songs and harmonizing with each other at night and on the weekends. Sometimes, music was the only thing getting me up in the morning and motivating me to go to school. Although I could often be at school for over 14 hours between all my musical commitments, I would much rather be enduring that than have no music in my life at all.

Mathematical Background

Growing up, mathematics was not a strong suit for me. Although it sometimes made sense immediately, oftentimes I needed concepts explained to me more than once. Throughout my academic career, I remember only a few experiences within mathematics that have stuck with me until today. In 7th grade algebra, my teacher taught us a song that

I can still sing to this day to help us remember the quadratic formula to the tune of Pop Goes the Weasel.

"X equals negative b

plus or minus the square root

of b squared minus 4 ac

all over 2a."

The other vivid mathematical experience I still carry with me was in twelfth grade Calculus class. We were learning about derivatives and I was completely lost, as was the rest of my class. My best friend and I were in the same class and asked our teacher if we could write a song about derivatives for extra credit. She enthusiastically agreed and my friend and I spent several consecutive lunch periods studying derivatives and putting our knowledge into musical form. Although the song ended up being less than two minutes long, eleven years later I can still remember every word and would likely be able to apply that knowledge to a derivative, if ever I was faced with one. Other than these two musical experiences, I can hardly recall most of my mathematics experiences between elementary and high school. However, I can remember one night trying to work on calculus with the aid of my father and getting so frustrated that I threw my notebook across the room screaming, "I hate math!"

The first time I found myself actually enjoying math was in my graduate studies. I registered for the Teaching Elementary Mathematics class and prepared myself to hate every minute of it. Math was never fun for me, so why would this class be any different? However, I found myself deeply engaged in the concepts and themes throughout the

Teaching Mathematics course. I finally understood why you had to “carry the one” in subtraction! I was able to invent my own strategies and explain my thinking to my peers. My academic life was changed forever.

I am confident that my experience with mathematics in elementary, middle, and high school was not a unique one. There are certainly many people who shared my intense distaste for mathematics and who never understood the concepts the way that they were presented to them. Math is such an important subject and one that was always described to me by teachers as building blocks, building off of one another. They explained to our classes that if you don’t understand the elementary concepts, you won’t be able to learn the middle or high school concepts. Each block relies on the one below it to stand strong so that the entire structure won’t topple over completely. Basically, if students don’t understand mathematics in the primary years, it is significantly more difficult to catch up and make up for that loss later on (Boaler, 2002).

This is why it is so important to create positive and meaningful mathematical experiences for students from the beginning of their academic careers. Students decide early on if they are “good” or “bad” at certain subjects and often carry these identities throughout their lives. Unfortunately, many students who fail early on at math might possess a negative outlook on the subject that could squash any mathematical aptitude they may possess (Boaler, 2002). I can’t help but wonder: if math and music had been integrated early on in my academic career, would I have a different outlook on mathematics today?

Project Rationale

For this project, I will be guided by the research question, *How does infusing music into elementary mathematics curriculum affect student learning and engagement?* From this study, I hope to learn how integrating music with mathematics affects how students learn and engage with academic material. I have been working at an elementary school in a first-ring suburb of the Twin Cities area since January of 2017. After receiving my elementary teaching license in December of 2016, I accepted a position as a Title I reading teacher at this school. I served as a second grade teacher during the three school years between 2017 and 2020. During the 2020-2021 school year, I taught third grade. I will be teaching second grade at another school in my district during the 2021-2022 school year.

Our district emphasizes standards-based instruction in an attempt to increase test scores and our students' academic knowledge. This means that teachers are trained and taught to teach to the standard rather than based on any sort of curricular resource. Students are presented with grade-level concepts and expected to master the skill before moving on to the next standard. Due to the rigorous pacing in mathematics, concepts are often not taught or are skimmed over, thus leaving gaps in student learning. I believe that students aren't given enough time or differentiated access points to master the content because there is quite a bit of pressure to fit all grade-level standards in before the end of the year.

A unique characteristic of the school I work at is that we are a part of a program called Turnaround Arts. This is a program that brings arts education, resources, and

funding into high-needs schools to try to combat the opportunity gap and decrease behavioral issues. Our third through fifth grade students (and sometimes younger ones) have the opportunity to participate in a culminating musical and theatrical performance at the end of the year, which I have co-directed with a colleague since 2017. This musical contributes significantly to our positive school culture and climate, due to the fact that many students who struggle academically and behaviorally in the classroom are able to shine on stage. They sing, dance, and act, all while utterly and completely in their element. Their talents and passions often bring tears to my eyes during rehearsals and performances. Watching them makes me think about what our students could achieve if they had the opportunities to channel their musical and artistic interests and talents in the general education classroom setting. Each year, this experience reinforces to me that there are so many different sides to the students in our classrooms at school. Unfortunately, oftentimes we only get to see the academic side.

Does it have to be that way, though? Many researchers would say no. There has been extensive work and research conducted on multiple intelligences and learning styles, and although there have been conflicting accounts, one concept rings true: education is not one-size-fits-all. Howard Gardner (1989) pioneered multiple intelligence theory and claims that people can be intelligent in numerous ways. He claims that the multiple intelligences are musical-rhythmic, visual-spatial, verbal-linguistic, logical-mathematical, bodily-kinesthetic, interpersonal, intrapersonal, and naturalistic. Each person is intelligent in some of these categories, but may be lacking in others. Intelligence, to Gardner, exists on a continuum rather than a binary (Gardner, 1989). The same is true with learning

styles. Students (and people in general) learn best in different ways. There are four main learning styles: visual (seeing), auditory (hearing), kinesthetic (moving), and tactile (touching). The important thing is to be aware of the fact that even though you may not be as apt to learn through one of these styles, you might be intelligent in other ways or learn better via a different access point. Children all learn, think, and perceive the world differently and it is our job as educators to provide them multiple opportunities and modalities through which to learn academic concepts.

My project aims to incorporate music into mathematics lessons in an effort to increase engagement and learning. By integrating musical learning activities, brain breaks, and a variety of assessment opportunities into an existing second grade mathematics curriculum, I hope to improve the cultural relevance, engagement, and learning retention that these students experience. My hope is that using songs and music to teach second grade academic standards will allow students to interact with the content in a deeper way that can reach and engage more students than the traditional way of teaching math currently does. In addition, differentiating the assessment opportunities to include the option to create a song or a rap to demonstrate mastery of content can open the door to proficiency for students who are not as confident taking tests in the standard way.

Conclusion

My personal and professional background has informed my interest in this research study on infusing music into mathematics education. My love for music has been lifelong, although my genuine interest in mathematics has only just begun. My work

is guided by the research question: *How does infusing music into elementary mathematics curriculum affect student learning and engagement?* I have seen countless examples of students who do not necessarily excel in the traditional classroom shine when given musical and artistic opportunities in extra-curricular activities. This makes me wonder about the potential impact of utilizing something that students are already passionate about to increase their learning in a curricular subject area. Would integrating this interest in music allow for students to become more engaged with mathematics through interdisciplinary learning? It is my hope that this research will prove to be useful for teachers who are pressured to increase test scores and are looking for an alternative that will educate their students through emphasizing multiple intelligences and learning styles.

In Chapter Two, I detail a summary of the current literature regarding Multiple Intelligence Theory and how it manifests in schools as well as a spotlight on musical intelligence specifically. The chapter also includes an exploration of learning styles, differences in demographics, and how they affect knowledge acquisition in the classroom. Next comes a discussion of best practices for teaching mathematics including the importance of culturally relevant instruction, classroom discussion, students' invented strategies, and the use of higher-order questions. Barriers to teaching in this way are also discussed. Finally, I review the current literature regarding teaching mathematics and music in tandem in the classroom and its effects on students' engagement and learning.

Chapter Three details the curriculum revision project that I created and includes the intended audience, timeline, and assessment of efficacy of the project itself. Finally,

Chapter Four serves as a conclusion to the capstone, including a reflection on the project as a whole, a discussion of future research that may be conducted, an analysis of limitations, and how the project may benefit the profession as a whole.

CHAPTER TWO

Literature Review

Introduction

In this study, I aim to answer the research question: *How does infusing music into elementary mathematics curriculum affect student learning and engagement?* The first section of this literature review explores the theory of Multiple Intelligences and their application in a classroom setting. It also goes into greater detail about musical intelligence. The next section addresses learning styles, typical demographic differences, and how learning styles can be utilized in the classroom. The section after that will review best practices for teaching mathematics. The final section explores the integration of music and mathematics in the classroom and the effects of this on students' engagement and learning, along with the effects on the learning environment. The literature review concludes with a rationale for the proposed research as well as a conclusion tying the research findings together.

Multiple Intelligences

Overview

In many places, intelligence is determined by an hour-long test that requires participants to answer questions regarding vocabulary, mathematical knowledge, information storage, word associations, and a series of tasks (Gardner, 1983). After the test's conclusion, an examiner scores the participant's performance and comes up with a number that indicates her intelligence quotient, or IQ. People take this numerical score at

face value as their comprehensive measure of intelligence. The higher the number, the more intelligent one is deemed to be.

This was the norm for years, until Gardner (1983) challenged the status quo. *Frames of Mind: the Theory of Multiple Intelligences* detailed seven different types of intelligence that all humans are capable of possessing. The intelligence types are linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal (Gardner, 1983). Rather than defining intelligence by a simple number, Gardner views each of these intelligences as existing on spectrums. Humans have a certain amount of intelligence in each category, but each intelligence is independent from the others and the amounts of intelligence one has in each category are not stable (Gardner & Hatch, 1989). One type of intelligence doesn't necessarily influence the others. For example, if a student is musically intelligent, this fact does not mean that he or she has high linguistic or spatial intelligences as well. These seven intelligences are present in all human beings and are capable of development and growth over time.

In this section, multiple intelligences in the classroom will be explored by examining the existing literature on how to implement the intelligences into instruction and how they can influence learning and engagement. Then the focus will shift to musical intelligence and its development.

Multiple Intelligences and Education

According to Multiple Intelligence Theory, humans are capable of being intelligent in seven distinct categories that can benefit them throughout their lives, but only two of these intelligences serve students well in traditional schools (Gardner &

Hatch, 1989). Linguistic and logical-mathematical intelligences have long been considered the most important and most predictive of academic success of all of the intelligences. However, determining a student's intelligence based on two of seven intelligences offers a limited view of his or her complete intelligence profile. Much like determining academic success based on a single standardized test score, defining intelligence based on only two factors does not give a full picture of a person's abilities. Integrating multiple intelligences into classroom instruction can allow students to access academic content in ways that utilize their unique strengths and talents.

Multiple intelligence-curriculum infusion can materialize in a variety of ways. For example, teachers can involve multiple intelligences by devoting specific classes to the development of multiple intelligences or allowing students to participate in project learning experiences that incorporate a variety of intelligences (Gardner & Hatch, 1989). These student-driven projects allow for children to decide the topic of their exploratory project and which intelligences to employ in order to best complete the project. Teachers can also use multiple intelligences to teach a particular subject via intelligence-specific centers that students rotate between (Campbell, 1990). This method allows students to explore the same topic in seven different ways, allowing for a more thorough and multifaceted understanding of the academic concepts. Another way that teachers can incorporate multiple intelligences into their classrooms is by developing a unit that carefully infuses the intelligences throughout (Özdermir et al., 2006). Similar to center-based instruction, this method allows students to experience the same content through multiple modalities over the course of a unit.

Multiple intelligence theory can easily be applied to assessments as well. Traditionally, paper-and-pencil tests with multiple choice and short-answer sections have been frequently administered in the classroom. In an effort to generate a more complete picture of a student's understanding, teachers may allow students to present their knowledge in a variety of ways. Students can create portfolios or "process-folios" where students' growth can be documented over the course of the unit (Gardner & Hatch, 1989). By creating these portfolios, teachers can more adequately assess the progress students make from the beginning of the unit to the end, rather than merely analyzing the results of a paper-and-pencil posttest. Students' knowledge can also be gauged by reviewing journal entries, group projects, posters, and self-reflections (Özdermir et al., 2006). Teachers may be able to gather a more comprehensive view of their students' conceptual understanding by allowing them to express their knowledge in ways that highlight multiple intelligences.

Teachers have found many benefits to incorporating multiple intelligences into the classroom (Özdermir, Güeysu, & Tekkaya, 2006; Campbell, 1990; Gardner & Hatch, 1989). Teachers who often experience behavior problems or a lack of engagement during lecture-based instruction have found that incorporating multiple intelligences into their instruction significantly decreases the amount of off-task behavior and engagement issues in the classroom (Gardner & Hatch, 1989; Campbell, 1990). This is likely due to the fact that students are able to participate in more hands-on learning activities that stimulate different intelligences inherent within the students. When immersed in multiple intelligence instruction, students may learn to become more cooperative, work as a team,

and enhance latent leadership skills (Campbell, 1990). Students who may not necessarily excel in linguistic or logical-mathematical intelligence could take a leadership role when exploring a musical, spatial, or interpersonal learning center.

Some researchers have found that employing multiple intelligence instruction allows for students to look at the same academic concept in new ways and flexibly move among modalities in order to form a more comprehensive picture of the content. Interpreting the information in ways that make sense to students have proven to have effects on learning and information retention over time (Özdermir et al., 2006). In an experiment comparing two fourth grade classes learning about the Diversity of Living Things, Özdermir et al. (2006) taught one section of the standard science curriculum via the traditional lecture- and reading-based method. The experimental section, however, was taught the science curriculum incorporating all seven multiple intelligences. At the end of the study, the experimental group scored significantly higher on the post-test as compared to the control group. Even more remarkable is that, when tested on the same assessment two months later, the experimental group still scored significantly higher on the test while the control group scored lower than they had on the initial posttest. This finding suggests that the students in the multiple intelligence experimental group both learned more throughout the unit and retained the learning over a relatively long period of time. Additionally, students attending Multiple Intelligence specialty schools have been shown to score higher across all academic subjects compared to students at traditional schools (Snyder, 1997).

The role of the teacher may also look different in a classroom that employs multiple intelligence instruction. By allowing students to take charge of their learning, the role of the teacher can shift from the keeper of knowledge to more of a guide or facilitator (Campbell, 1990). During center-based or project-based learning, children are encouraged to explore and construct learning for themselves (Gardner & Hatch, 1989; Campbell, 1990). Teachers guide students to particular resources or give hints regarding how to go about something, but they do not give students answers outright. This benefits students because it gives them more buy-in to their educational experiences and allows them to develop their knowledge at a pace that is appropriate for them individually. Which intelligence might partner well with instruction in this student-centered way?

Musical Intelligence

Musical intelligence is present in all humans and is often the first intelligence to noticeably emerge in the first few years of life (Helding, 2010). Babies can recognize and respond to a song, which suggests that human brains are predisposed to interpret music (Hodges, 2000). All human beings regardless of their age, gender, exceptionalism, and race have the capacity to respond to and participate in music (Hodges, 2000). This is a phenomenon unique to humankind, but musical intelligence is often not intentionally developed by parents or caregivers. Oftentimes this intelligence is underemphasized in favor of the more academically-oriented linguistic and logical-mathematical intelligences. Why isn't musical intelligence valued, when humans have such a unique capacity to interact with it? How can this universal learning tool be incorporated into traditional education so more people have access to learning?

Although underemphasized in a traditional school setting, musical intelligence has been shown to have many benefits for those who participate in it. On a neurological level, children who are exposed to more music are often more capable of regulating their emotions compared to children with less music exposure (Snyder, 1997). This is because one of the neurological music centers lies within the triune brain, which is also responsible for emotion regulation and higher-level thinking. When children regularly exercise this part of the brain by listening to and participating in music, they strengthen the neocortex, which in turn allows for them to open the gate to higher-order emotional processing and thinking. If this neurological gate is not regularly used, the reptilian brain often wins out and a fight or flight reaction is more likely when confronted with an emotional situation (Snyder, 1997).

Although music was once theorized as being contained in the right hemisphere of the brain, recent research shows that there are actually musical centers in the left, right, top, bottom, front, and back of the brain. This means that listening to and participating in music can engage many different parts of the brain at the same time (Hodges, 2000). By participating in musical experiences, you can traverse the corpus callosum separating the two hemispheres with agility, which is often a difficult thing to do (Helding, 2010). Additionally, musicians have more gray matter in the brain, which are regions of the brain responsible for memory, emotion, speech, sensory perceptions, and muscle control (Helding, 2010). This means that musicians may have increased abilities in these areas compared to people who do not actively participate in music. Thus, the question remains: how can we incorporate these findings into the traditional model of education?

Students who participate in the development of musical intelligence can benefit in many ways. Self-esteem, the single highest predictor of school success, can be strengthened by exposure to music in the classroom (Snyder, 1997). Students who are not predisposed to think linearly can use music as an outlet for their unique talents and can also use it as a method to transfer knowledge and skills to other content areas and intelligences. Students participating in music also develop social skills in a safe environment where collaboration is valued over competition. These students can enhance their comprehension strategies by comparing and contrasting musical pieces, describing what they hear, and explaining their thoughts to their teachers and peers. Listening skills, literacy, problem solving, and critical thinking are also aspects of education that are influenced by musical experiences (Snyder, 1997).

In today's society, emphasizing linguistic and logical-mathematical intelligences as well as test scores, a lack of funding has caused budget cuts to subjects outside of core curricular content in schools, such as the fine arts. This is a significant problem for students who are motivated to go to school because of their experiences in a music program (Snyder, 1997). Schools that cut music and art programs often see a decrease in test scores along with an increase in dropout rates (Snyder, 1997). Students in these schools also tend to have fewer critical thinking skills and exhibit more violent tendencies than students at schools participating in music programs, since the neocortex is weakened and the reptilian brain is allowed to take over more frequently (Snyder, 1997). If test scores truly are valued in schools, why not invest more in music education?

Although there are many benefits to music education and the development of musical intelligence, it is important to not overgeneralize the research and claim a causal relationship between music and academic success. Certain studies have shown that students who participate in music have higher SAT scores than those who do not. While this may be true, it is not necessarily the music study itself that can solely account for the high scores (Demorest & Morrison, 2000). Rather than attributing the difference in scores to music study itself, it may be that students who choose to participate in music have certain characteristics that enhance their academic study skills or time management. Researchers and teachers must be wary of interpreting evidence such as this as a causal relationship between music participation and test scores or academic achievement. However, there is research to indicate that students who participate in pull-out music lessons and students who participate in music for several consecutive years do maintain higher levels of academic achievement compared to their peers (Demorest & Morrison, 2000). This combats the popular opinion that removing students from class for music lessons and enrichment severely impacts their learning and achievement.

Summary

Gardner's theory of Multiple Intelligences challenges the common assumption of what intelligence is and how it manifests in humans. According to Gardner (1983), humans have seven distinct intelligences that they can develop and grow over the course of their lives. Although people may have unique talents and gifts, intelligences are not static and are capable of growth (Gardner, 1983). He posits that schools place too much emphasis on linguistic and logical-mathematical intelligences at the expense of

underdeveloping the remaining five. Schools that incorporate multiple intelligences, however, have seen many benefits. Students in classes that emphasize different methods of knowledge acquisition show higher levels of engagement along with lower instances of negative behavior (Campbell, 1990). These students also have a chance to develop cooperation and leadership skills while constructing their own knowledge in an environment where the teacher is more of a guide than the sole keeper of knowledge. Students participating in multiple intelligence instruction also may learn more deeply and retain this knowledge for a longer period of time as compared to students immersed in traditional learning experiences (Özdermir et al., 2006). The development of musical intelligence specifically has shown many benefits for those involved. Along with increased neurological development, music students may experience higher self-esteem, comprehension, problem solving, and critical thinking skills compared to their peers (Snyder, 1997). Incorporating music into the educational system seems to be a low-risk way of increasing student achievement. Although students involved in music may score higher on standardized tests than others, there is not enough research to determine the correlation between these items. It may be that students who choose to study music are predisposed to having stronger study habits or time management skills than their peers, rather than music causing the higher test scores themselves (Demorest & Morrison, 2000). Additionally, students who participate in pull-out music programs and music in general maintain higher scores than their peers on academic measures. The research suggests that developing and utilizing multiple intelligences in the classroom can provide students with engaging experiences and deeper learning of academic content than would

occur in a traditional classroom setting. This research project aims to bridge the gap between underemphasized musical intelligence and learning math. Why wouldn't administrators and educators want to invest in music to enrich their students' educational experiences? This chapter now turns to a discussion of learning styles and suggestions regarding how to effectively implement them into the classroom.

Learning Styles

Overview

Humans receive, process, and communicate information in unique ways (Collinson, 2000; Haar et al., 2002). The ways that people go about manipulating information have been defined as four main learning styles: visual, auditory, tactile, and kinesthetic. Visual learners tend to absorb and retain new information best when presented with reading material or pictures. Auditory learners prefer to listen to a lecture when acquiring new information. Tactile learners prefer using manipulatives and experiencing the learning with their hands, while kinesthetic learners enjoy using their whole bodies such as in role-playing or high-movement activities to learn (Dunn & Dunn, 2005).

Within these four categories of learning are many factors that play a role in determining how people learn best. Learning styles often take into account cognitive processing, emotional abilities, and physiological needs (Collinson, 2000). The environment in which the learning takes place may have an effect on how the student processes information. People have certain preferences regarding noise level, temperature, light, and design of the immediate environment. Inherent in each person is

also a level of emotionality regarding motivation factors, persistence, structure preference, and level of personal responsibility. Some people prefer to learn alone, others prefer to work in partners, and still others prefer to work in larger groups. People may be motivated by teacher interaction, parent interaction, or student interaction. Finally, physical characteristics affect student learning as well and are related to the traditional four learning styles detailed above, but also include food and water intake, time of day, and mobility preferences (Collinson, 2000).

Although it may sound simplistic to have just four learning styles to choose from, the reality is that there are countless factors that affect how students learn best. Learning styles take into account genetic makeup, individual experiences, as well as the context of the learning environment (Collinson, 2000). In this section, we will explore the current research on learning styles and examine how they manifest among students in the classroom.

Demographic Differences

As student bodies diversify, teachers must be able to learn how to teach to each student's strengths, weaknesses, and learning preferences (Haar et al., 2002). Although each student's learning style is based on a variety of personal factors, the research shows that there are some trends regarding students of different academic achievement levels as well as gender differences. This by no means proves that all high achieving students have a particular learning style or all boys have a certain learning style. The following section is merely a summary of the existing research on trends regarding student demographic differences.

Underachieving and high achieving learners show varied differences regarding learning style preferences (Collinson, 2000). When examining students with high academic achievement in the classroom, a few things become clear: Students who have auditory or visual learning styles are often higher achievers in the classroom because traditional learning is in the form of lectures (auditory) and assigned readings (visual) (Dunn & Dunn, 2005). Females are more likely to have auditory or visual learning styles, while males tend to have tactile and kinesthetic learning styles (Eiszler, 1983). High achieving students often prefer to work alone rather than in groups, and can thrive in informal educational environments. These learners are more self-directed, responsible, flexible, persistent, and teacher and adult-motivated than their lower-performing peers. They prefer having multiple options for academic tasks and don't mind a lack of structure (Collinson, 2000).

Underachieving students, on the other hand, prefer to work in pairs or groups to learn, rather than independently. They may also have poor auditory memory, and prefer to learn visually through pictures, graphs, or charts (Collinson, 2000). Although underachieving students want to do well in school, their inability to recall facts and information presented in lectures and readings keeps them from performing at a high level (Collinson, 2000). Males tend to show a preference for tactile and kinesthetic learning, which are the least emphasized learning styles in traditional schools (Eiszler, 1983). Kinesthetic learners often find it difficult to sit still in their chair for longer than 12 minutes at a time, and prefer to process information by talking while listening, rather than being passive listeners (Dunn & Dunn, 2005). Most average learners perform better

on academic tasks when using tactual materials, while underachieving students perform significantly better when using manipulatives (Dunn & Dunn, 2005). Additionally, underachieving students show a preference for learning difficult material during the afternoon hours rather than in the morning (Collinson, 2000).

Auditory Versus Visual Learning: A Case Study

Budoff & Quinlan (1964) attempted to conduct a case study to test young children's auditory learning and compare their findings to their visual learning. The task for the fifty-six second graders in their study was to learn to associate random word pairings with each other. In the first case, a second grader would be presented with a visual representation of a word. They would then need to point to the word's pair, before the time was up and the word was revealed. In the second case, a word was spoken by a tape recording and the student's task was to speak the corresponding word before the recording could. The goal of the study was to see how quickly children learned via visual stimulation versus auditory stimulation. On average, the second graders learned the aural word-pair association by the 16th trial, while it took them twenty-six trials to successfully learn the visual word-pair association. This study, although limited in its scope, could make a case for using auditory over visual learning in the primary classroom. This theory may lend itself well to implementing music and other auditory stimuli to promote learning and information retention.

Summary

Teachers' knowledge of their students' learning styles and preferences is key in being able to effectively instruct them. Although students' learning styles are affected by

variations in genetics, lived experiences, and learning contexts, it is true that students learn best in different ways. Some students prefer visual stimuli, others prefer auditory, while yet others thrive on tactile and kinesthetic experiences. These four categories can be further broken down into subcategories that involve different levels of visual perception, as well as different preferences within auditory, tactile, and kinesthetic learning (Eiszler, 1983). Although it may be tempting to pigeonhole students into one of four types of learners, this may actually be detrimental to their success. For example, if a visual learner thrives on learning via visual stimulation, providing this student with a reading task may not result in an optimum learning experience (Eiszler, 1983). Teachers must take the time to view individual learning differences within the four categories, rather than affixing one of four permanent labels onto their students. Teachers who emphasize learning styles view the diversity of their students as challenges rather than impediments, use students' prior knowledge and experiences as foundations for learning, use manipulatives and literature to provide hands-on experiences for students to construct new learning, hold high standards for all students regardless of learning style, and examine their own viewpoints and beliefs of different student demographics to keep them from informing their teaching (Haar et al., 2002). A thorough knowledge of learning styles is necessary for teachers to provide the type of instruction that will be most beneficial for all learners in the classroom. This research on learning styles informs my project by reinforcing the importance of differentiating instruction based on individual students' preferred methods of learning. The next section focuses on suggestions for the best practices for teaching mathematics.

Teaching Mathematics Best Practices

Overview

The teaching of mathematics has remained relatively constant over the past century, despite advice from the National Council of Teachers of Mathematics to reform instructional methods (Towers, 2012). Teachers often lecture and pass on information about formulas and procedures without allowing students to first build a foundation for understanding the concepts. Drill, repetition, and reproduction of information have been at the forefront of mathematics teaching for quite some time. Because of this, students often see mathematics as a predetermined set of rules and procedures that have no resonance in their lives (Sheppard, 2011). Although many teacher preparation programs today educate prospective teachers about the importance of hands-on learning and inquiry-based instruction, when these new teachers enter the classroom, they often fall back into old habits of teaching mathematics. They teach mathematics as they were taught growing up and often emulate the teaching practices they see around them- ones that emphasize the technical aspects of mathematics education rather than the real-world application of concepts (Towers, 2012).

Mathematics, as in any type of learning, does not occur in a vacuum. In order to make mathematics meaningful for students, teachers must help them apply the concepts to their own lives (Radford, Schubring, & Seeger, 2011). The National Council of Teachers of Mathematics (NCTM) advocates for students to learn mathematics through mathematical activities that reinforce concepts, using multiple strategies to solve problems and being able to transition from one strategy to another flexibly, using

discussion as a basis to inform instruction, and probing students' thinking to help them think more deeply about the mathematical concepts (Neumann, 2014). What are each of the ways students can be prompted to construct meaning out of mathematics?

Culturally Relevant Teaching

Students learn best when educators intentionally incorporate their interests and backgrounds. However, traditional teaching of mathematics is overwhelmingly catered to the middle-class, Caucasian experience (Sheppard, 2011). This traditional way of teaching mathematics emphasizes sitting still, listening to a lecture, and taking notes, even though this matches a very small percentage of students' learning styles (Gardner & Hatch, 1989). As such, minority students are often at a disadvantage when it comes to obtaining scholastic success before even setting foot in a school. Creating links between abstract mathematical concepts and these students' real, lived experiences are key to creating positive mathematical experiences (Sheppard, 2011). Teachers should get to know students fully and use this knowledge to inform teaching them mathematics. Using situations that students encounter on a regular basis can help them to see how mathematics is applied in the real world and transfer their knowledge to novel scenarios (Boaler, 2002).

Sheppard (2011) conducted a study of pre-service teachers and African American students in the primary grades to see how culturally relevant teaching affects learning and knowledge acquisition. Over the course of 15 hours of one-on-one tutoring with these students, the pre-service teachers got to know them and what motivates them outside of school. The pre-service teachers then used this knowledge as a basis for creating

mathematical problems rooted in their lived experiences. For example, one pre-service teacher learned that her student went to his grandmother's house every Sunday and baked cookies. She used this information to create a division question about chocolate chips and cookies. Immersed in the context of the problem, the student was able to solve a type of math problem that until then was too abstract for him to comprehend. Another pre-service teacher in the study created a song to teach her student about how to tell time. Sheppard (2011) noted that part of the historical structure of African American culture is the importance of rhythm and pattern. By creating a link between what this student already knew and appreciated and an abstract concept, this pre-service teacher created opportunities to make mathematics applicable to his life and thus began helping him build a deep-seated foundation of mathematical knowledge based on experience.

Classroom Discussion, Invented Strategies, and Higher-Order Questioning

Oftentimes in mathematics, when a student provides an answer to a problem, the teacher either defines it as correct or incorrect, and the class then moves on to the next problem. Although this is useful in identifying whether or not the student was "right" or "wrong," it does nothing to expand students' knowledge of the topic and the processes behind it. Students must be involved in a discourse about the mathematics rather than merely giving a number as an answer and moving on. They need to understand the process, not just the product (Neumann, 2014).

Teachers can facilitate this discourse by creating a classroom discussion surrounding the processes and strategies that students use to get to their answers. Since students do not all think the same way, teachers must listen to the explanations of their

answers to gain insight into the inner workings of their brains (Neumann, 2014). When posing a math problem, teachers can ask students what they did to get their answer in order to bring their invented strategies to the forefront of learning (Towers, 2012; Neumann, 2014). Asking students to describe their strategies challenges them to think about the process rather than the product, as well as allows them to think about the math at a deeper level. By promoting mathematical discussion in the classroom, students can learn strategies from each other that they can try out when doing similar types of problems (Neumann, 2014). When children share their invented strategies, their peers are encouraged to think of the math from a perspective they may not have considered before. Children also tend to want to try out these strategies to see if they work, and in the process they create faster and more efficient ways of solving mathematics problems (Neumann, 2014).

Teachers must also be able to ask higher-order questions and probe students' thinking during these discussions. Teachers are encouraging students to understand the mathematical processes behind their thinking by asking them questions like, "How did you get your answer?" (Towers, 2012; Neumann, 2014). Asking these higher-order questions can give teachers insight into the concepts and processes that their students comprehend completely as well as those that their students need more exposure to. Part of this process involves educating oneself about common misconceptions that students might have about mathematical concepts (Sheppard, 2011). By making oneself aware of these misconceptions, teachers can better prepare for common threads in students' thinking and can predetermine ways to guide students to the correct ways of thinking

about topics. Discussion, invented strategies, and higher-order questions can all help create students who are flexible problem-solvers and have a deep and rich understanding of mathematical concepts.

Barriers

Although teachers may know that inquiry and discussion-based teaching of mathematics is the best practice, there are several barriers to teaching this way in the classroom. For one, an educational society based on achievement and standardized test scores may not be welcoming of discussion-based instruction and invented strategies (Towers, 2012). Teachers also may be faced with using a standards-based curriculum or be given curriculum materials that are to be taught from. These materials may not emphasize the best practice strategies detailed in the above sections. Mathematics textbooks may detail the proper steps to teach mathematics, but they may leave out a lot of depth of knowledge about the way that math can be personalized. New teachers interested in inquiry-based practice may not have the knowledge about resources to collect a comprehensive curriculum when only given a math textbook as a tool (Towers, 2012).

Teachers also may not be comfortable teaching in a way different from how they were taught growing up (Frykholm, 2004). Despite learning new, effective teaching methods through teacher preparatory courses, when new teachers enter the classroom, many revert back to teaching as they were taught in elementary school, rather than instructing the way they were taught in college (Frykholm, 2004; Towers, 2012). This

cognitive dissonance between theory and practice can be a significant barrier to best practices for teaching mathematics.

Another issue regarding successful implementation of mathematics best practices is an unsupportive or uninformed administration. Principals who are informed regarding the importance of student inquiry and discussion surrounding mathematics can be advocates for educators who wish to try out these techniques (Towers, 2012). However, principals who are uninformed and colleagues who are unfamiliar with these methods may be unsupportive of teachers' desires to implement this type of learning. This could lead to teachers shifting back to traditional methods of teaching, in order to fit the mold of the school they are teaching in. Although there are several barriers to effective implementation of mathematics best practices, it is important for student comprehension and depth of knowledge that teachers instruct in a concrete way that incorporates students' backgrounds and interests to account for a variety of learning styles and socio-economic statuses.

Summary

Teachers likely grew up in a mathematical world where low-level questioning, repetition, drill, and practice were common (Neumann, 2014). Although this has been the norm for many years, research shows that it is not an effective way of cultivating deep understanding from students. In order to reach our students today, we must take into account their individual experiences, ideas, and thought processes. Our students must be made aware of the connections between abstract mathematical concepts and the real world (Radford, Schubring, & Seeger, 2011). Teachers of mathematics must be skilled in

taking objective concepts and creating learning activities that are subjective, cultural, and personal for their students. How can educators integrate musical intelligence with math in order to deepen conceptual understanding? The next section explores the connection between music and mathematics, as well as how to effectively integrate the two in the classroom.

Music and Mathematics Integration

Overview

Music and mathematics have a deep-rooted and complex relationship. Mathematical concepts are inherently intertwined into music theory, notation, and performance. The nature of music is artistic and expressive, but is rooted in theory that involves knowledge of mathematics. Numerical relations, probability, integers, proportions, and logarithms are just a few mathematical concepts that relate to the musical intervals, rhythms, melodies, scales, harmony, and tuning (An et al., 2013). However, music and mathematics have traditionally been taught as separate subjects. Rather than appreciating and making connections between the two disciplines, teachers often teach these subjects in isolation. This may be a disservice to students who are musically gifted but are lacking in mathematical skills, or vice versa. If these subjects were brought together more often, the knowledge gained in one could inform the other and students would be able to think more flexibly as well as apply the concepts in context (Still & Bobis, 2005). Music can provide the cultural and personal relevance that can bridge the gap between hands-on experiences and abstract mathematical concepts (An & Tillman, 2015).

In this section, the connection between music and mathematics in the classroom will be explored. The focus will be on the potential benefits as well as limitations of this integration and practical ways to infuse music into mathematics instruction.

Music and Mathematics Integration in the Classroom

Teachers and researchers may have a variety of different reasons they wish to try to infuse music into their mathematics curriculum. Perhaps their school has experienced budget cuts and they want to find a cost-free way to enrich the education of the students in their classroom

Others may want to integrate the two subjects in order to see if there is an increase in mathematical understanding and achievement (An & Tillman, 2015; Courey et al., 2012; An et al., 2013; Still & Bobis, 2005). Still others may be more interested in the relationship between music and spatial intelligence or ability (Ky, et al., 2012). Each of these methods will be explored in this section in order to gain a comprehensive picture of how music and mathematics interplay in the classroom.

The majority of the literature on the topic of music and math integration is focused on whether or not incorporating music allows students to form a deeper understanding of the mathematics concepts at hand. Researchers go about this integration in different ways. Some researchers integrate in phases, placing more emphasis on either music or math at each phase in order to seamlessly incorporate the two together in a gradual progression (An & Tillman, 2015; Courey et al., 2012). For example, researchers may begin with music as the main focus and gradually add in elements of mathematics during each phase until the students are completely immersed in mathematics at the end.

This way, the students have the musical knowledge as a foundational base from which to build their conceptual knowledge of mathematics. Another way to go about music-math integration is more casual. Some researchers have found that incorporating songs and chants as well as clapping rhythms can help solidify mathematical concepts as they are being taught (Still & Bobis, 2005). In this method, teachers aren't necessarily digging into the roots of musical theory and notation in order to make deep connections between the subjects. Instead, they are eliciting familiar musical concepts that can help their students see math through a new lens. This approach may lend itself well to primary grades, whereas intermediate grades may benefit from a more sophisticated approach to integration (Still & Bobis, 2005).

Researchers who have implemented music-math integration have seen a variety of results from their experiments. Some have noted a shift in the classroom climate. Students seem more motivated, collaborative, reflective, and inquisitive as a result of the integration (An & Tillman, 2015). Others recognized the complete absence of behavior problems from even the toughest students in class (Courey, 2012). Oftentimes behavior issues emerge from students who are bored or not engaged in the topic. By providing a musical platform for learning mathematics, students have a familiar context with which to navigate abstract academic concepts (An et al., 2013). In other words, students are able to apply their existing musical knowledge to unfamiliar mathematical concepts through music-math integration. By taking into consideration students' preexisting knowledge, cultural backgrounds, and personal contexts, teachers can more effectively teach their students in ways that are accessible and applicable for them (Still & Bobis, 2005).

In terms of academic effects, music-math integration has been shown to elicit increases in achievement in the classroom. Several researchers have found that experimental groups who are exposed to music-math integration score significantly higher on math post-tests than control groups who are just exposed to the mathematics curriculum (An & Tillman, 2015; Courey et al., 2012; An et al., 2013). Additionally, although all students may benefit from the music integration, students who perform lower on pretests may show larger gains on the posttest than students who perform higher initially (Courey et al., 2012). This could be because the lower-performing students learn mathematics better through different modalities than just lectures and readings. The hands-on musical experiences may enrich these students' understandings in math and benefit them in a way that the initially higher-performing group may not necessarily require. Additionally, students in experimental groups may be less likely to leave problems blank on a test and may be more willing to apply learned concepts to novel problems (Courey et al., 2012). This could be because the experience learning math via different intelligences encourages knowledge transfer between subjects and contexts, rather than merely subject-specific knowledge. Another explanation could be that the students in the control group had less experience exploring the concepts and spent more time dealing with mathematical notation and abstractions. The researchers in this study also found that students in the control group were less likely to take risks answering questions that were worded differently than they were used to, while the students in the experimental group were more likely to apply the knowledge they learned to unfamiliar questions (Courey et al., 2012).

Some researchers credit increased engagement in the subject for the enhanced learning and achievement exhibited by students in the experimental group (An et al., 2013; Still & Bobis, 2005). Music may have been the hook that initially captured the students' attention and held their interest when integrating mathematics later on. Students learn more when they are engaged in the matter at hand, so introducing music as the engaging factor could be an effective way to increase students' motivation to learn mathematics (An et al., 2013). After one teacher told a musical story that incorporated hidden mathematical concepts, he noted that he couldn't get his students to stop talking to each other about the characters, themes, and concepts that were intertwined throughout the tale (Still & Bobis, 2005). These students were unknowingly engaged in mathematical discussions that ended up extending their thinking and improving their knowledge through the engaging lens of music and storytelling. Students are motivated by a collaborative, student-centered learning environment that centers around discussion about concepts, problem solving strategies, and processes (An & Tillman, 2015).

Summary

Music and mathematics are two seemingly separate subjects that actually have quite a bit of overlap. Traditionally, these subjects have been taught separately and in isolation, however the research shows that it may actually benefit students to integrate the two. Using music as a vehicle to teach mathematics has been shown to engage students by providing them with a real-world context before introducing abstract mathematical concepts (An & Tillman, 2015). In addition to engagement, students' discussions about mathematical concepts and their musical counterparts deepen their knowledge about both

subjects (Still & Bobis, 2005; An & Tillman, 2015). Students in experimental groups that implemented music integration also outperformed their peers who experienced traditional mathematics instruction and took more risks when faced with novel problems on the posttests (Courey et al., 2012; An & Tillman, 2015; An et al., 2013). Based on the existing literature on the topic, music and math integration seems to be an effective strategy to teach mathematics in an engaging way based on the lived experiences of students in the classroom.

Rationale for Research

This study aims to explore the connection between mathematics and music in an educational setting. In addition to learning the traditional mathematics curriculum, participants in the study will be able to experience mathematics through hands-on activities that emphasize music and reinforce mathematical concepts. The participants' pre and post-test scores will be compared to their pre and post-tests scores in a previous unit in order to gauge the effects of integrating music into the mathematics curriculum. Data will also be collected on the percentage of students engaged during lessons that integrate music compared to ones that are purely mathematics instruction. Participants will be able to reflect on the process of infusing music into mathematics through a survey administered three times throughout the study. Additionally, a small group of participants will participate in interviews with the hope of learning the effects of the implementation strategies on student learning and attitudes towards mathematics. This study will explore the effects of implementing multiple intelligences into the elementary school classroom.

Conclusion

Traditionally, schools emphasize linguistic and logical-mathematical knowledge starting in kindergarten and extending through high school. Schools also focus on auditory and visual learning styles and neglect to emphasize tactile and kinesthetic modalities, even though this may not be in the best interest of the students. This emphasis limits the learning opportunities of students who are not linear thinkers, which can in turn disenfranchise these students from current and future educational opportunities. Integrating multiple intelligences and learning styles into the mathematics classroom is a strategy to combat this disenfranchisement and make learning engaging and accessible for all students in the classroom. Through incorporating multiple intelligences, students are exposed to a variety of perspectives of looking at the same concept. This method also encourages students to apply their conceptual knowledge to different contexts, rather than being limited by the context they are in when the learning occurs. Music is an example of an intelligence that has deep connections with mathematics concepts and is something that students often have prior experience with before entering school. Providing students with hands-on, culturally relevant, and engaging activities creates a student-centered learning environment that is not only more engaging for students, but also fosters higher levels of achievement than teaching subjects in isolation.

Next, Chapter Three details my project design and includes the context for my project, the overview and description of the project, the setting and participants, the project timeline, the frameworks and methodologies used in creating the project, and the assessment of project effectiveness. Finally, Chapter Four serves as a reflection on the

creation of my project and includes my major learnings, a discussion of the most important aspects of the literature review, implications and limitations of my project, suggestions for potential future research, how I will communicate my findings, and how my project benefits the profession.

CHAPTER THREE

Project Description

Introduction

The purpose of this chapter is to describe my project and to provide rationale behind it. The goal of this project is to answer the research question: *How does infusing music into elementary mathematics curriculum affect student learning and engagement?* This chapter includes four major sections. The first section provides an overview of the chosen project, including its description, the setting, audience, and timeline. The second section elaborates on why this project was developed and the research paradigm chosen for this project. The third section explains the research and methodology that supports the capstone project. Finally, the conclusion will summarize the key points of this chapter and introduce Chapter Four. The next section describes the purpose for my capstone project.

Context

The purpose of my capstone project is to provide three units of a revised math curriculum for second grade teachers that integrates music with mathematical concepts and content. The project idea was developed based on my varied personal and professional experiences with music and math as well as the existing literature regarding multiple intelligences, learning styles, teaching mathematics best practices, and music and mathematics integration. The next section will describe my project overview and description.

Project Overview and Description

The project that I created was based on my own personal experiences with music and math as well as the literature review detailed in Chapter Two. My project is a revised version of three units of second grade mathematics curriculum. It includes lesson plans and teaching slides as well as a teacher script for the first three lessons of each of the three units. As a teacher myself, I appreciate scaffolding and modeling in order to grow in my own pedagogy. However, I also appreciate the flexibility to take curricula and mold it to match my teaching style. Because of this, I hope that the unit plans as well as the nine lessons I have fully created provide a foundation for this work, while also allowing teachers to take what they like and assimilate it into their own teaching styles in their classroom. This is not a one-size-fits-all approach, so teachers should feel comfortable modifying the provided lessons in a way that is personal to and comfortable for them.

My district recently adopted the math curriculum McGraw Hill- Reveal Math to use in the 2021-2022 school year. We used Math in Focus in prior years, so this change in curriculum will come with a learning curve for teachers, administrators, and students alike. Because we will be using the new curriculum for the first time starting in the fall, this year will be a transition year for teachers, which will involve digging into the new curriculum, pulling out the standards and objectives for each unit and lesson, and finding ways to make the content and concepts relatable and accessible to our students. The curriculum revisions that I created involve integrating music into each unit in the form of newly created songs that align with second grade academic standards, opportunities for musical brain breaks, ideas for background music that will promote a calm and

productive workspace, as well as performance assessment opportunities that allow for students to be creative in the ways that they express their learning and concept mastery.

Music to Promote Learning

The songs that I created with a former music teacher of mine include melodies that are familiar to many students (such as the Happy Birthday song) with new lyrics that reinforce conceptual and procedural understanding of addition and subtraction. Because the songs are tunes that a lot of students may already know, my hope is that they learn the new lyrics quickly and efficiently so they can spend most of their time remembering the words and concepts, rather than having to learn a new melody as well as novel lyrics. This worked for me in 7th grade algebra class, when my teacher taught us a concept using a mathematical song sung to the tune of "Pop, Goes the Weasel," so I hope that this is an effective strategy for our younger learners as well.

Music During Brain Breaks

As an educator, I know first-hand the importance of brain breaks during lessons for students to get up and move around to "wake up" their brains after sitting for too long. The songs that I have chosen to include as suggestions for brain breaks are songs that are up-tempo, exciting, and will encourage students to move around the room quickly to expend some energy for a couple of minutes and get their bodies and minds moving again. One example of a brain break song that I included in my curriculum revision is the Flight of the Bumblebee by Rimsky-Korsakov (arr. Rachmaninoff). This song serves as an auditory representation of the excitement and whimsy of a bumblebee taking flight and will encourage students to move around the classroom quickly and perhaps even act

out the mental image of bumblebees flying around. Of course, these brain breaks must be quick and safe, as well as not interfere with learning. When used correctly, brain breaks are efficient tools to increase attention and engagement and my hope is that by intentionally adding songs that invite students to move quickly, they will get out some of their energy and return to their work spaces ready to tackle the next part of the lesson.

Music During Work Time

Conversely, during work time, it is important to create an environment that promotes calm and productivity. My project also includes ideas of music and songs that are midtempo or slower and those that are orchestral or classical arrangements. These songs do not contain any lyrics, so that students do not become distracted by words being sung while attempting to focus on their work. However, some students may be distracted by music in general during work time. It is important to talk to your students about their preferences before implementing background music in your classroom so that it benefits the maximum number of students possible. In a classroom with 1:1 technology, students may be able to listen to music on their laptops or iPads using headphones during work time. However, this is not a reality in all settings, so teachers will need to use their professional judgement to determine if this is a beneficial aspect of the project for them to include in their classrooms.

Music for Assessment

The final component of my project offers suggestions for differentiated summative assessments so that students are able to express their learning in more creative ways than paper-and-pencil tests. In my experience as an educator, oftentimes students

that are able to correctly answer questions in small or whole group settings struggle to answer the same questions on traditional assessments. For some students, the time limit (or perceived time limit) creates anxiety; for others, the word "test" creates stress for them; and for others, that method of assessment just isn't right for them. In my revised curriculum, I have outlined different structures to provide students with so they can demonstrate their learning in a different way. Perhaps they might create a rap to show that they can solve the answer to 48 + 37. Alternatively, they could rewrite the lyrics to one of their favorite songs in order to demonstrate their learning. The purpose of this part of my project is not to provide a step-by-step assessment plan, but rather to create open-ended opportunities for students to choose from, in case they are not as comfortable or confident with the traditional methods of assessment.

Summary

This section provided a detailed description of my capstone project. This curriculum revision project includes transforming three existing second grade math units from McGraw Hill- Reveal Math curriculum to include musical learning activities, musical brain breaks, music during work time, and opportunities to use music and creation of music during assessments. The next section outlines the setting and participants of the study.

Setting and Participants

I work in a school district that is located in a first-ring suburb of the Twin Cities. The district is comprised of students who are 39% white, 30% black, 15% Latinx, 9% two or more races, 6% Asian or Pacific Islander, and 1% Native American. 10% of

students in the district are English Language Learners and 51% of students qualify for free or reduced-price lunch (Minnesota Report Card 2021).

The school I will be working in during the 2021-2022 school year has different demographics than our district as a whole. This school is composed of students who are 34% black, 23% two or more races, 21% white, 13% Latinx, 8% Asian or Pacific Islander, and 1% Native American. At my school, 15% are English Language Learners and 70% of students qualify for free or reduced-price lunch (Minnesota Report Card 2021). While the majority of students in our district are students of color, most teachers are white, middle-class women.

In terms of academic achievement and proficiency as measured by standardized mathematics test scores, students in the state of Minnesota between 2016-2019 have gone from 60% proficient to 55.4% proficient. Our district, by comparison, has gone from 40.2% to 36% proficient over the same timeframe (Minnesota Report Card, 2021). My school has gone from 32.6% to 31% proficient, so we are slightly below the district proficiency level and significantly lower than the statewide proficiency level.

This section provided detailed information regarding the demographics of the students who attend my district, as well as those who attend my elementary school. Statewide data was compared to district-wide and school-wide data in terms of academic proficiency. This information provides the context for my capstone project. The next section will discuss the timeline of project completion as well as how long the project will take to execute in a second grade classroom.

Timeline

This project was mainly developed during the summer of 2021. The initial idea and brainstorming occurred in the winter and spring of 2020/2021, while the actual construction of the project including the curriculum revision, music creation, and unit plan design occurred in the summer of 2021.

The three units that I have revised within the McGraw Hill-Reveal Math second grade curriculum are called Meanings of Addition and Subtraction, Strategies to Fluently Add Within 100, and Strategies to Fluently Subtract Within 100. Each unit has 10 lessons embedded within them and the pacing guide suggests spending 16 school days on each unit, which equates to just over three weeks of instruction per unit, or about nine and a half weeks of instruction in total.

This section detailed the timeline of both the project completion as well as a projected timeline for how long the project will take to execute in a classroom setting. The following section discusses the frameworks and methodologies used in developing my capstone project.

Framework and Methodology

Multiple Intelligences

Gardner (1983) first introduced the theory of multiple intelligences to the world and detailed a new meaning of the word "intelligence." Gardner (1983) posits that there are seven different intelligences, each of which exists on a spectrum, and he states that one type of intelligence is no more or less important or real than the others. The intelligences that I used in the development of my project are logical-mathematical and

musical intelligences (Gardner, 1983). The aim of my project is to observe if and how the two intelligences affect one another. When taught in tandem, do they enhance each other or hinder each other? Much of the existing research suggests that music and math are complementary to one another and I hope that my project will add to the existing literature regarding this theory.

Learning Styles

Human beings do not all learn or process information in the same way. There are four main learning styles, which can be classified as visual, auditory, tactile, and kinesthetic (Dunn & Dunn, 2005). Learning environment can also have an effect on how learners process information. For example, people have different preferences regarding light, temperature, noise level, and the design or organization of the environment (Collinson, 2000). Traditional teaching is often presented in the form of lectures and assigned readings, which does not reach all students or address all learning styles (Dunn & Dunn, 2005). This leaves a gap in opportunity and learning for students who prefer to learn via underemphasized methods. This project aims to close one part of the opportunity and learning gap by incorporating music and movement with aspects of traditional instruction in an effort to engage more students and increase learning and retention of information over time.

McGraw Hill- Reveal Math Curriculum

The curriculum that served as the foundation of the mathematical aspect of my project is McGraw Hill- Reveal Math. This curriculum allows students to view themselves as problem-solvers and mathematicians by promoting and actively

constructing students' growth mindsets (McGraw Hill, 2021). Along with teaching mathematics, Reveal Math includes a social and emotional learning objective in each lesson in order to create and maintain a positive learning environment where taking risks is safe and valued. Many of the learning experiences within this curriculum are centered around sense-making and allowing students to create their own understandings of concepts. The curriculum includes activities at the beginning of each unit intended to engage students' curiosity and make them want to know and learn more about the problem or puzzle. Each lesson also contains a "low floor, high ceiling" launch activity where all students' voices are heard and respected during a classwide discussion about what they notice and wonder about the introductory problem (McGraw Hill, 2021). Students' academic math language skills are also at the forefront of Reveal Math, because math does not just deal with numbers and operations- it is a completely unique way of communicating. Reveal Math integrates "WIDA-based English Learner Scaffolds, Math Language Development Focus and Math Language Routines" throughout each lesson (McGraw Hill, 2021). This allows students to engage in academic conversations and discourse with their teachers and peers regarding the content they are learning.

Reveal Math is also standards-driven with a flexible lesson design to fit every type of classroom and situation. There is a strong emphasis on effective teaching practices, such as promoting mathematical discourse in the classroom, guidance about higher-order questioning techniques, and an emphasis on encouraging productive struggle and perseverance (McGraw Hill, 2021). Reveal Math assessments are aligned with the instructional design of the program and include "analysis, recommendations, and targeted

intervention resources" (McGraw Hill, 2021). It also includes math probes to bring common misconceptions to light so that students can interact with tricky problems and explain their thinking and how they avoided the common misconceptions. The alignment of all aspects of the Reveal Math curriculum aided in the efficacy of my unit plans.

Understanding by Design

Many teachers use the textbook as the entire curriculum and plow through it with their students page by page each day, attempting to "get through" all of the content necessary by the end of the academic year (McTighe & Wiggins, 2012). However, this method of instruction is not particularly conducive to student learning or retention. Students need a learning plan that is thoughtful, intentional, and thorough. I used the Understanding by Design framework to design the three math units that I revised. When teachers plan their lessons, they should use a backwards design, or plan by starting with identifying what they hope students will be able to know and understand by the end of the unit (McTighe & Wiggins, 2012). After identifying the desired results, you can plan for assessment. Teachers should ensure that the assessments they develop are completely aligned with the learning objectives and goals. In other words, teachers should not assess items that are not directly related to the learning objectives. Once the objectives and assessments are aligned, teachers can begin planning learning activities and the actual instruction that they will implement each day.

In each stage of unit planning development within the Understanding by Design framework, teachers should focus on three types of goals: "transfer, meaning making, and acquisition (T, M, and A)" (McTighe & Wiggins, 2012, p. 6). A lot of traditional teaching

revolves around acquisition, or teachers teaching basic concepts without allowing students time to make meaningful connections or transfer their learning to new problems and situations (McTighe & Wiggins, 2012). When students are taught primarily through acquisition, learning is more easily forgotten than when students are able to make meaning and participate in learning tasks that allow for them to transfer their knowledge (McTighe & Wiggins, 2012).

This section reviewed the four frameworks and methodologies I used when developing my project: multiple intelligences, learning styles, McGraw Hill- Reveal Math curriculum, and Understanding by Design. The following section details methods to assess how effective the project is at doing what it is intended to do.

Assessment of Project Effectiveness

Academic Assessment

In order to determine whether or not this project is effective, an individual second grade class or a pair of second grade classes can compare pre- and post-assessment results. A detailed explanation of how to compare these results is discussed in the next section. When comparing one class to itself, one unit of math would be taught with fidelity based entirely on the Reveal Math curriculum. The following unit of study would be taught using one of the unit plans detailed in this project. The pre and posttests for each unit would be administered identically, so that outside factors are not responsible for differences in test scores.

When comparing two classes to each other, the classes would both take the pretest as outlined in the Reveal Math curriculum. Then the control class would be taught the

academic content based on the lessons outlined within the curriculum. The experimental class would be taught the content using the unit plan detailed in this project. After the mathematics content has been taught, the students would take the posttest. The pretest and posttest will be identical to each other except for the numbers used. The tests will also be administered the same way to ensure reliability (Creswell, 2014). The test items would be read aloud to students in small groups, while the rest of the class is working on math tasks independently. This eliminates the possibility of skewed results due to students not being able to read test items. Proceeding in this manner also assures internal validity, in that students' mathematics skills are being tested rather than their ability to read the questions accurately (Creswell, 2014; Mills, 2007). This quantitative research tool can be used to measure academic growth made in the content area after the content has been taught.

Academic Assessment Analysis

In order to analyze the outcomes of the study, a t-test will be applied to the pre and posttests (Creswell, 2014) of the music-integrated content compared to the pre and posttest of the mathematics unit (or control group) taught without integrating music. The purpose of the t-test will be to evaluate whether or not the independent variable (music integration) had any effect on the dependent variable (students' learning). If there is not a statistically significant difference between the two pretest scores, but there is one between the posttests, it can be assumed that the music integration is the factor responsible for this shift in significance, rather than a random factor.

Summary

This chapter provided the context for this project, as well as a detailed project description and overview. The demographics of the students in the district and school involved with the project were described, as well as the academic proficiency levels of the district and school as compared to the state of Minnesota. The timeline of project completion and project execution was also detailed. Additionally, the framework and methodology that informed the project was detailed. Four frameworks served as the foundation for this project: multiple intelligences, learning styles, McGraw Hill- Reveal Math curriculum, and Understanding by Design unit planning. Finally, the methods of assessing the effectiveness of the project were discussed.

Chapter Four will provide a reflection on the development of this capstone project. I will revisit my research question: *How does infusing music into mathematics curriculum impact student learning and engagement?* The reflection will detail what I learned throughout the process of developing my capstone project, what limitations surround the project, as well as suggestions for future research regarding the topic.

CHAPTER FOUR

Conclusion

Introduction

The purpose of this capstone project was to answer the question: *How does infusing music into elementary mathematics curriculum affect student learning and engagement?* The first three chapters of this paper consisted of an introduction to the project and its purpose, a literature review, and a description of the project. Chapter Four serves as a reflection on the process of creating the project and will include sections consisting of personal learnings, a summary of the literature review, implications and limitations of the project, recommendations for future research or projects related to this one, how the research will be communicated to others, how this project serves as a benefit to the profession, and concluding thoughts.

I created this project because, as a prior elementary student who struggled with mathematics concepts but excelled in music, I see the benefit of integrating the two in order to increase engagement and solidify learning. Many students at the school I teach at who are not interested in math or feel that they're not good at math come to life when music is incorporated into the classroom. I developed this project in order to combine music and math in a way that may excite and engage students who otherwise might have a negative relationship with mathematics. I have worked with many students who are completely in their element while on stage singing and dancing. This caused me to wonder why singing and dancing are exclusive to extra curricular activities. Sadly, in many schools, these passions are not incorporated into daily instruction. My hope is that

by providing a blueprint for how music and math integration can be done, it will open up new possibilities for teachers and students, even at schools where the fine arts budget is minimal or nonexistent. Teachers don't need to have a specialized degree in music to incorporate it into their instruction and engage students who would otherwise be left behind.

Major Learnings

When I first began brainstorming what my project could be, I had a very broad idea: studying the impacts of integrating music into general elementary instruction. When combing through all of the existing literature about education and music integration, I found that I needed to be more specific with my research question. Rather than elementary education as a whole, I decided to focus on mathematics instruction. Math is a subject that many students (as well as adults) struggle with. It also happens to be a subject that naturally lends itself to music integration. Both music and math involve patterns and other elements that promote a natural relationship between the two (An et al., 2013). When I noticed how excited my own students were when I played music in the classroom, I thought that integrating music with math would be a good choice. Math has a logical structure and progression, whereas reading instruction can be much more subjective and circular in nature, thus, creating songs based on math concepts was a more natural choice for integration.

Through my research, I learned that several researchers share my passion for integrating music and other intelligences with mathematics instruction. However, most of the existing literature involved research studies with high school students, rather than

younger learners. I hope that this project will serve as an example of how music can be incorporated into elementary education as well as higher level education.

Revisiting the Literature Review

Several articles from my literature review were very influential on my capstone project. Gardner's (1983) work regarding multiple intelligences served as the foundation for the creation of my project. Without his flagship research, I would not have had a starting point or any idea about the existence of multiple intelligences in general, let alone the details regarding musical intelligence. Hodges (2000) reinforced my belief in the importance of musical experiences by detailing the unique predisposition that all humans have to respond to and participate in musical experiences from birth, regardless of their age, gender, race, or exceptionalism. The research by Still & Bobis (2005) found that incorporating chants, songs, and clapping rhythms helps solidify mathematical concepts. These pieces of research encouraged me that incorporating music into general education curriculum, and especially math instruction, was the right path for my project.

Other pieces of research within my literature review affirmed my belief that music can allow students to thrive and flourish in many ways, not just academically. An & Tillman (2015) noted that music integration promoted an increase in collaboration, positive classroom climate, motivation, reflection, and inquisitiveness among students. Snyder's (1997) research found that musical experiences aid in emotion regulation as well as increase the capacity of higher level thinking due to opening and enhancing neurological gateways. Self-esteem can also be strengthened by music exposure in the classroom, which is the single highest predictor of academic success. Listening skills,

literacy, problem solving, and critical thinking also can be influenced by an increased exposure to music. On the other hand, schools that cut music and art programs often experience a decline in test scores and critical thinking skills, as well as an increased dropout rate and an increase in violence among the student body (Snyder, 1997).

When creating my daily lesson plans, I was mindful of including links between students' lives, experiences, and interests and mathematics concepts in order to create more positive mathematical experiences in the classroom. I learned that creating these links are of paramount importance for student engagement by reviewing Sheppard's (2011) work. One way this appeared in my planning was in my Anchor Tasks. When creating these tasks, I included students' names, popular snacks, friends' and family members' names, video games, celebrations, apps, sports, and other things to make the math more real for students. I also incorporated many opportunities for students to explain their invented strategies with partners and the class, as well as built-in times for math discourse where students are able to learn strategies from each other (Neumann, 2014). I have found that the more students are able to engage in speaking about math, explaining their thinking, and listening to others' strategies, the more deeply they are able to comprehend the concepts and transfer strategies to novel situations.

Other researchers noted the increase in learning, retention, and knowledge transfer among students who were involved in music-math integration as shown by post-test scores (An & Tillman, 2015; Courey et al., 2012; An et al., 2013; Özdermir et al., 2006). The goal of education in general is to maximize the amount of conceptual understanding, procedural ability, flexible thinking, and knowledge transfer, so these research studies

encouraged me that integrating music with math instruction is beneficial to students on multiple levels.

Implications and Limitations

The implications of my project will hopefully allow for an increase in professional development regarding integrated instruction in general. Widespread budget cuts in schools and districts may mean that students have less instruction in specialist classes such as physical education and music, so incorporating music and other multiple intelligences within the general curriculum can be a cost-free way to still immerse students in that type of education (Courey et al., 2012). I also hope that my project will influence stakeholders and policy makers to invest more money in these specialized subjects so more collaboration can take place between classroom teachers and specialists. Furthermore, I hope that this project can show students, families, teachers, and administrators alike that there are many culturally relevant ways to experience and teach mathematics, and integrating music is one of those methods.

A limitation of my project is that students' knowledge of popular culture songs and classic songs will likely change over the course of educators' teaching careers. While songs by Taylor Swift and Drake will be recognizable to students in 2021, there will be different music artists in future years that students enjoy listening to. Because of this, teachers may want to tweak the tunes or lyrics of some of the songs provided in order to fit the current musical interests of the individual students in their classes.

Potential Future Research

Music integration can be valuable to the world of education in many ways. It certainly does not have to be specifically paired with mathematics in order to be beneficial. I encourage future researchers to expand on this research by creating projects that incorporate music with other content areas such as reading, writing, science, and social studies. It could also be easily integrated into other classes like art, physical education, foreign languages, and media.

Music integration should not just be reserved for primary grades. Future researchers could explore integrating music with other educational subjects in intermediate elementary grades as well as middle school and high school. Some of my most memorable experiences in middle and high school were in choir and band. It is exciting to imagine how many more meaningful learning opportunities could come from integrating music into other content areas at the upper level. Researchers could create curricula for these levels that dig deeper into music theory and the foundational connections between music and math that would not be developmentally appropriate for younger students. Students who have a poor relationship with math in the upper grades likely did not have engaging or interesting experiences with math when they were younger. How wonderful would it be to repair that relationship and renew their interest and self efficacy regarding their ability to do math and to do it well?

Researchers could also create a curriculum that is more musically immersive. I took an existing mathematics curriculum and revised it by incorporating a few aspects of music, but future researchers could try the opposite and begin with a completely

music-based curriculum, while gradually integrating mathematics concepts. The goal of my project was to integrate the two without taking the focus away from mathematics concepts and instruction, but there are various ways to incorporate math and music.

Another suggestion for future research would be for music teachers to more purposefully connect mathematics standards to their music curricula. By intentionally making these connections and interacting with these concepts, students could more easily transfer their learning from music class to the general education classroom and vice versa. This could potentially increase students' ability to think flexibly and transfer their skills beyond the classroom in the real world as well. Math education does not occur in a vacuum, and the more opportunities educators provide for knowledge transfer, the more likely our students will be able to retain and flexibly utilize the skills that they learn in school.

Communicating Results

I plan on communicating the results of this capstone project with my current and prior elementary schools. The original audience I had in mind when creating my project was the elementary school that I taught at previously, so I will communicate the results with the second grade teachers, administrators, and instructional coaches in that school in order to enrich their mathematics instruction. In addition to that school, I will communicate the results of my project to the other second grade teacher and principal at the school I will be starting at in the fall.

My plan is to communicate my results with teachers of other grade levels as well. I have heard from many third and fourth grade teachers that their students completely

forget how to regroup when adding and subtracting. By teaching these songs in first or second grade, they could be used in upper elementary grades as well as a review and a reminder of foundational concepts and processes. How incredible would it be for students from kindergarten through fifth grade to be able to learn the same songs and sing them to help them remember how to go about solving a specific problem? My goal is for this to be adapted for every grade in my elementary school to ensure a more cohesive structure throughout students' elementary years.

I also would like to communicate my results with second grade teachers in other school districts in order to widen the scope of my project. Further, I would love to expand that communication to other grade levels and extend it to middle and high school levels as well. I expect there to be some pushback from some teachers because not everyone is as musically inclined as myself, but I think that providing the opportunity to integrate music with mathematics will be useful even if not every teacher is comfortable using it.

Benefit to the Profession

This project benefits the profession by offering a pathway to teaching mathematics that is engaging and exciting to elementary students. My students often jump up and start dancing when their favorite song comes on, and this project aims to connect that level of joy and excitement with teaching and learning mathematics. Some teachers may feel that this integration would be too time consuming and would take away from the actual teaching of mathematics. There are teachers I have spoken to that have voiced these types of concerns, whether it be integrating general instruction with music, art, or technology. What these teachers fail to realize, in my opinion, is that combining

two or more concepts can help make the learning more real and grounded for their students as well as allow for them to retain information longer rather than forgetting it once the math unit is over. My project includes a list of already-created lyrics to several familiar songs so teachers don't have to start from scratch when it comes to integrating music with their math curriculum. I also include multiple suggestions for music during brain breaks and work time, so teachers don't need to spend their time researching and looking for these songs either.

This project is also beneficial to the profession because it is grounded in the Understanding by Design (UbD) unit plan framework. As educators, we know that there are so many routines, rituals, and other components embedded within a mathematics curriculum that we can not viably get to every single thing within our math block. By creating unit plans using the Understanding by Design framework, I have pulled out the most important concepts, skills, and procedures that students need to solidly understand. Teachers will still have access to their curriculum if they are able to fit in more of the math rituals and routines, but I have provided a foundation and the first few lesson plans for three units so that teachers have a starting point for teaching in this integrated way. Teachers can make copies of the lesson slides and add, edit, or omit things that don't align with their teaching style. They can also use the lesson slides to develop more lessons that utilize their curriculum and their personal pedagogy and perspectives. This project is not a one-size-fits-all checklist. It is meant to serve as a framework and basis for interpretation, allowing for teachers to mold and adapt it to fit their individual students.

Summary

The purpose of this capstone project was to answer the question: *How does infusing music into elementary mathematics curriculum affect student learning and engagement?* Chapter One served as an introduction to the project and discussed my musical and mathematical background as well as the reasons I chose to create this project. Chapter Two included a review of the existing literature surrounding my topic. The four main topics that were explored were multiple intelligences, learning styles, teaching mathematics best practices, and music and math integration. The literature and research within this review not only increased my knowledge and understanding of each topic, but also reinforced the innate connection between music and mathematics, which encouraged me to continue building and refining the vision for my project. Chapter Three detailed my project design and included the context for my project, the overview and description of the project, the setting and participants, the project timeline, the frameworks and methodologies used in creating the project, and the assessment of project effectiveness. Lastly, Chapter Four served as a reflection on the creation of my project and included my major learnings, a discussion of the most important aspects of the literature review, implications and limitations of my project, suggestions for potential future research, how I will communicate my findings, and how my project benefits the profession.

I have learned so much throughout the creation of this capstone project. My hope for the future is that this project will create an entry point for students who, like me, do not have a natural affinity for math. I can only imagine how my mathematical career could have been enhanced by having the opportunity to interact with mathematical

concepts through musical experiences in elementary school. If this project helps even one student find and develop their love for math or increase their self-esteem when solving math problems, then I will count this project as a success.

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