MUSIC,
COGNITIVE DEVELOPMENT,
AND
SUCCESS IN THE SCHOOL ENVIRONMENT

by

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ABSTRACT

This paper presents a review of research that investigated the relationships between active participation in learning and playing music, as well as listening to music, on cognitive development, academic achievement, and a productive and meaningful school environment. This paper begins with an overview of the profession conversation, controversies, and trends that surround the reviewed research. A historical overview of the understanding of the relationship between music and areas of the intellect within the Western world is given, as well as the integration and development of music into the public school curriculum in the United States. The research chapter of this paper reviews and critiques the research studies. These studies are divided into five sections including working memory and test performance, literacy, math and spatial skills, background music in the classroom, and using music to create a meaningful and productive school environment. The studies established a small relationship between active participation in learning and playing music and enhanced cognitive and academic performance, and an enhanced school atmosphere. Results from the studies that investigated the effects of background music were weak. The last chapter of this paper presents implications for the classroom as well as suggestions for further research.

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CHAPTER ONE: INTRODUCTION

Introduction

Humans since the time of the ancient Greeks have reflected upon the relationship between music and learning. While most public schools today include music in their curriculum, music's place often falls at the mercy of other academic subjects and time spent in preparation for standardized tests. Recent research explored the relationship between music participation and intellectual achievements and enhanced school environments. The goal of this paper is to answer the question: What can recent research tell education professionals about how music participation can enhance academic achievement, cognitive development, and learning environments in school? The first chapter of this paper will explain the context of, as well as the controversies and trends surrounding, the recent literature base that explores this issue. Chapter two will explore the historical basis of this question. Chapter three will provide a review of the research base of studies that have implications for this question. Finally, based on the findings revealed in chapter three, chapter four will explore implications for the use of music in the school environment and give recommendations for further research

Rationale

In today's public schools, meeting the needs of all students has become increasingly challenging. Educational paradigms need to be changed so that schools can serve all students effectively (Eady &Wilson, 2007). Shehan, Connell, & Beegle (2007) stated that, "From a developmental perspective, music appears at every stage and age of human growth. In adolescents as in infancy, childhood, and adulthood, music plays a valuable and valued role in the individual's social-emotional and intellectual-artistic domain"

(p.1). If this statement is true, professional educators would be wise to understand the implications of music in the learning environment, and investigate what role music can play in public schools. However, music holds an uncertain position within the public educational system in the United States of America. While the No Child Left Behind Act signed by George W. Bush in 2001 incorporated the arts, including music, as a core subject, an emphasis on state and national standardized testing to promote and evaluate academic learning in the areas of math and English took money and energy away from music programs in public schools (Hansen, Bernstorf, & Stuber, 2004). Additionally, recent studies indicated a decline in the instructional time given to music programs in public schools due to cuts in funding. (Abril & Gault, 2007)

A body of empirical research studies in the past decade explored the relationship between music participation and cognitive abilities, academic success, and positive school atmosphere. Whether educators teach music in their classroom for the sake of music itself, or integrate music into curriculum to facilitate the understanding of another academic subject, or whether they are advocating for the continuance of music class outside of the regular classroom, it is important for public educators to explore the benefits of music education in order to not overlook a potential positive academic intervention.

Many researchers have sought to find justification for music curriculum through its ability to improve achievement in other academic areas such as reading and mathematics. Some researchers, however, believed that music should not be justified through its ability to enhance academic subjects, and that doing so is potentially detrimental to the placement of music in public school curriculum. Rauscher (1999) stated, "If the arts are

given a role in our schools because people believe the arts cause academic improvement, then the arts will quickly lose their position if academic improvement does not result" (p.3). With a similar stance, Hetland (2000) stated that as a result of music instruction, enhanced academic skill "will tag along, but it must never be the focus or the measure of a music program's success or failure" (p.224). While Rauscher strongly believed that music curriculum should not be judged by its ability to enhance academic achievement, she also stated that research should continue to investigate the relationship between music training and cognitive skills in order to not overlook an educational intervention that could have profound and positive implications. In an era of high stakes testing, finding a relationship between music participation and academic achievement may be valuable to preserve music's place in public school curriculum. It is important that decision makers at local as well as national levels learn more about the potential benefits of music in enhancing the goals of the educational community and whether what is learned through the study of music can be transferred to other academic areas (Abril & Gault, 2007).

A strong controversy that arose within the body of research that investigated the relationship between music participation and academic achievement involved the differentiation between listening to music and active involvement in learning and playing music. The belief that listening to music could make you smarter began with a study by the researchers Rauscher, Shaw, and Ky (1993) that demonstrated that the scores earned by college students on an intelligence test, in the area of spatial-temporal skills, briefly increase after the students listened to a Mozart piano sonata for ten minutes. The results of this study became a phenomenon known as the Mozart effect and proliferated through books and articles that popularized the notion that listening to the music of Mozart could

facilitate intellectual development. In later research, Rauscher (2006) maintained that the Mozart effect created what she called a scientific legend and misconception that listening to music could make you smarter and improve intelligence levels. She stated that the chief finding of the Mozart Effect study was, in fact, "that one specific composition of Mozart enhanced adult spatial test performance for up to about 15 minutes. There was no indication that other Mozart pieces would have this effect or that the effect was in any way specific to Mozart" (p. 233). Demorset & Morrison (2000) asserted that, "We should not promote the relatively untested contention that only the works of a single European composer possess some superior architecture that enhances general intelligence. If we do, then we are guilty not only of a poor application of science, but cultural imperialism" (p. 34). Rascher (2006) further stated that educators needed to be aware of the distinction between research focused on listening to music, and research focused on music instruction, which is a much more "cognitively complex and educationally significant phenomena" (p.236). Researchers who investigated the relationship between playing music and enhanced skills in other areas found that music training and the production of music, rather than just listening to music provided improvement in academic skills such as phonemic awareness and spatial-temporal abilities (Perret & Fox, 2004).

Recent research that investigated the effects of active music learning and playing, as well as listening to music, illuminated several perspectives on the ways in which music participation can affect cognitive development, academic performance, and the school environment – specifically transfer theory, neural connections theory, and the integration of music into curriculum to teach other subjects.

One of these perspectives was the transfer or near-transfer theory, which is based on the idea that learning something in one area extends to and facilitates learning in a different area (Hanson, 2003). According to the transfer theory, the skills involved in learning or listening to music can be transferred to other academic areas. An example of transfer in regards to literacy, was demonstrated when Butzlaff (2000) declared that "skill in reading requires a sensitivity to phonological distinctions, and skill in music listening requires a sensitivity to tonal distinctions" (pg. 167) and that "music and written text both involve formal written notation which must be read from left to right. In both cases, the written code maps onto a specific sound" (p.167). Gromko (2005) supported this notion when he stated that, "If the near-transfer hypothesis is correct, then it should be the case that when children learn to discriminate fine differences between tonal and rhythmic patterns and to associate their perceptions with visual symbols, they will benefit not only musically but in skills related to the processing of sound shown to be necessary for reading" (p.201).

Similar to the transfer theory, the neural connections theory suggested that musical and spatial tasks share the same processing centers in the brain and are neurologically linked; therefore, experience with one of these tasks will improve learning in the other task (Hanson, 2003). Hetland (2000) described the trion theory proposed by Shaw as, "musical and spatial processing centers in the brain are proximal and overlapping and hence linked, rather than being entirely distinct as predicted by modular theories of the mind. Because of this proximity, these researchers believe that music and spatial abilities share neurological connections in the cortex and are thus related activities" (p. 180).

Another perspective on the ways that music could be used to facilitate academic achievement involved the integration of music into curriculum in order to teach a subject other than music, such as math or English. An example of music-integrated curriculum could be the use of a song to assist in the memorization of vocabulary words. Support for integrating music into curriculum in such a way came from Howard Gardner's theory of Multiple Intelligence. Gardner (1983) stated that an individual's intelligence is made up of a number of different, integrated cognitive capacities, with certain capacities being more prevalent depending on individual strengths. Gardner's Multiple Intelligences include: linguistic, musical, logical-mathematical, spatial, body-kinesthetic, naturalistic, interpersonal intelligence and intrapersonal intelligence (Curtis, 2007). According to Gardner, students with musical intelligence are responsive to music, sound, rhythm, and tones, and they have success learning and memorizing information through songs and rhythm. Gardner also stated that musical intelligence is the earliest intelligence to emerge and it is closely related to linguistic intelligence (Gardner, 1983). The theory of Multiple Intelligence supported the integration of music into curriculum because it validated music as a medium through which individuals learn.

Limitations

This paper will explore the findings of research that investigated the affects of learning and playing music, as well as listening to music, on cognitive performance and success in the school environment. This paper will include studies that investigated the affects of music as a stand alone subject on cognitive development, as well as music integrated into the classroom as a way to teach another subject, or create a productive classroom environment. This paper will also explore the natural relationship that students

have with music in and outside of school. This paper will not include studies that investigated the effects of music instruction on student's achievement in the area of music. Although research has been done investigating the affects of music on special education students, this paper will focus mainly on students in regular education classrooms.

Definition of Terms

This paper defines academic achievement as the academic performance of students in school. Literacy is defined as the ability to read with understanding and write clearly. Background music is defined as music that is played when other activities are happening and is not the focus of attention. Transfer is defined as recurrence of skills obtained during musical participation in other academic areas.

Statement of Purpose

The purpose of this paper is to explore the recent research that investigated the relationship between music participation and listening to music on academic achievement and cognitive development, as well as student's natural inclinations towards music and how music can facilitate a productive learning environment. With this goal, this paper will explore research in the following categories: working memory and test performance, literacy, math and spatial skills, background music in the classroom, and using music to create a meaningful and productive school environment. The exploration of this research is done with the intent that the findings can be used to help educators use music to facilitate a productive learning environment for all students.

Summary

Recent research explored the relationships between music and intellectual development and academic achievement, as well as how music can create a productive and meaningful school environment, yet music holds a tenuous position in the public school curriculum. An emphasis on math and English as well as standardized testing took time and funding away from music programs in public schools. Due to this atmosphere, it is important for educators to take a close look at the body of research investigating the effects of music participation in order to not overlook potential developmentally appropriate teaching strategies. While some researchers believed that music should be justified for its own sake rather than for the sake of academic benefit, establishing a connection between music participation and academic success may help to secure music's place in the public school curriculum.

CHAPTER TWO: HISTORICAL BACKGROUND

Introduction

For hundreds of years, philosophers of the Western civilization contemplated the relationships between music and learning. Ables, Hoffer, & Klotman (1984) explained that "Education in music and debates regarding its value can be traced as far back as the fourth century B.C. Musical education has not developed in isolation, but rather in the social, religious, and economic context of the times. Understanding the sequence and the nature of the historical development of this movement helps us to understand better how the music profession arrived at its present position and may assist music educators in predicting future directions for music in American schools" (p.27). Chapter one explained the current context surrounding research that investigated the relationship between music and cognitive development and an enhanced school environment. This chapter will trace the understanding that humans in the Western world have had of the relationship between music and the intellect. It will also examine the developments that led to the integration of music education into public school curriculum in the United States. Chapter three will present and critique a body of research studies that attempted to establish a connection between music and intellectual development, academic achievement, and a productive and meaningful school environment. Based on the research findings in chapter three, chapter four will present suggestions for integrating music into the school environment as well as ideas for further research.

Ancient Greece

The ancient Greeks viewed music as important to intellectual development and closely related to mathematics. Aristotle believed that music facilitated relaxation, character building, and cultivation of the mind, and he considered music to be a necessary component to youth education and responsible citizenship. He also believed music to be important to leisure, an activity that he considered vital to intellectual development. Another famous ancient Greek philosopher, Pythagoras, made some of the first recorded connections between music and mathematics. He deemed music one of the four branches of mathematical knowledge. Pythagoras initiated the first study into musical scales. His study demonstrated how the plucking of two strings of equal tension, one half as long as the other, on a musical instrument, created notes an exact octave apart. This study demonstrated the first musical relationship made between ratios and proportions and is believed to be one of the first explanations of physical mathematics (Garland & Kahn, 1994). Pythagoras and his followers believed that music and math provided keys to the secrets of the world. In their doctrine of the Music of the Spheres they asserted that the heavenly bodies create sounds as they move through space, that the universe creates music. Mark & Gary (2007) explained that, "The Pythagorean school valued music because the same mathematical laws governed it as those that governed the universe, which one could understand through mathematical proportions. A person who understood musical proportions could understand the harmony of the universe. Music as a mathematical science became an important subject of study and remained so for many centuries" (p.9).

The Middle Ages

During the Middle Ages, music continued to be recognized for its intellectual as well as its aesthetic qualities. At the start of the Middle Ages, music attained a place in the quadrivium, the highest division of the seven liberal arts, along with arithmetic, astronomy, and geometry. (Ables et al., 1984). Mark & Gary (2007) explained that, "As the Middle Ages progressed, only two applications of music were recognized. *Musica discipline*, as part of the quadrivium, was related to mathematics and held the possibility of revealing to the scholar the secrets of physical reality. The other application was music as an art, or *musica sonora*, which was conveyed by the voice and musical instruments. It was the antithesis of *musica discipline*, not only because it was known through the senses rather than by reason, but also because it appealed to the emotions and influenced behavior. The two divisions of music reflected the practical study of music as a means of worship and the purely theoretical study of music as a mathematical science" (p.20).

Because music held an integral part in the Christian church services, music instruction became necessary. In the early stage of music instruction church goers transmitted music orally from one church to another, as no formal system of music notation existed. As a result, different music came to be performed in the monasteries and churches in Europe. The ninth century saw the development of a system of musical notation that allowed a standardized version of the chant to be performed throughout Europe. The creation of musical writing resulted in a phase of increased formalized music instruction. Towards the latter part of the sixth century music instruction not only included the standardized chant, but also increased instruction in singing as well as instrument playing, harmony, and composition (Ables et al.,1984).

The first organized singing schools, developed for the purpose of training singers for the church came about in the 1500's in Italy. These schools, called conservatories, cared for orphans and educated them with the aim that they would excel in music. In 1774, Charles Burney, who had observed these conservatories sought to establish a similar school in England. His idea did not meet with success. However, in 1822 the Royal Academy of Music in England opened its doors. The academy served as a boarding school rather than as an orphanage (Ables et al., 1984).

Music training in the New World

The early settlers in New England did not initially encourage music participation, as its pleasure producing qualities clashed with their Puritan background. Also, kept busy with other chores of settlement, such as building homes, cutting trees, and agriculture, they did not have time for pursuits such as music (Birge, 1966). As in the Middle Ages, the church came to be the primary place through which settlers obtained music training (Ables et al., 1984). When Puritan and other Protestant colonists of New England brought psalms that they had learned in the churches of England with them to America, these psalms were performed by ear, freely embellished upon, and rarely mirrored closely the original tune (Brophy, 1992). Birge (1966) explained that, "Of all the dismal accomplishments of public worship in the early days of New England the music was the most hopelessly forlorn, not only from the confused versifications of the Psalms which were used, but from the mournful monotony of the few known tunes and the horrible manner in which these tunes were sung." (pg. 3-4) The Singing-Schools were instigated as a way to train psalm singers for the church (Brophy, 1992). Priests taught singers how to follow notes written on the page in the correct melody and rhythm, greatly improving

psalm singing (Sunderman, 1971). As well as teaching singing, singing-schools became important social gathering places in towns and villages (Keene, 1982).

Pestalozzi and the integration of music into public school

Changes in society led to changes in the way that Americans taught music. The late 17th and 18th centuries brought an intellectual revolution, termed The Enlightenment, to Europe and America. Within this Enlightenment, theological belief and reasoning gave way to scientific reasoning and explanations. One of the most influential educational philosophers of the late 18th and 19th centuries was Heinrich Pestalozzi. Pestalozzi became influenced by the philosophies of the Enlightenment, specifically Jean Jacques Rousseau and his book *Emile*, which emphasized a natural, child-centered education (Keene, 1982). Pestallozi advocated for a scientific approach to education. He believed that the mind "begins with vague sense-impressions, which grow distinct, are followed by greater degrees of clarity, and evolve into descriptions" (Keene, 1982, p.81). He felt that the learner must not learn the complex until he or she has mastered the simple, and that educational curriculum should be taught to give the student the opportunity to learn in this manner (Keene, 1982). Pestallozi believed that students should be taught the science of music. "They must appreciate the differences among melody, rhythm, harmony, dynamics, starting with the rudiments and eventually being able to translate notation and musical characters into a familiar language; just as if they were reading the letter characters which are part of a language" (Sunderman, 1971, p.34).

In 1829, William C. Woodbridge brought Pestalozzian principles of teaching music to America after studying them in Europe. On August 24th, 1830, Woodbridge gave a speech at a meeting of the American Institute of Instruction. This speech was entitled "Vocal

Music as a branch of Common Education." Along with his speech, a group of children sang who had been trained under Lowell Mason, a church musician and singing teacher, with whom Woodbridge had shared his views and knowledge of the Pestalozzian music teaching methods. On November 14, 1837, Mason persuaded the Boston School Committee to let him initiate a new music curriculum at the Hawes School in Boston on a short term basis. At the end of this period, a concert given by Mason and his students successfully convinced the Boston School Committee to add musical training into the regular school curriculum. This event came to be known as the Magna Carta of Music Education, because it paved the way for the incorporation of music education into public schools (Brophy, 1992). The common school movement also facilitated the spread of music instruction into regular school curriculum, giving many children the opportunity for musical education (Mark & Gary, 2007). It is important to note that Lowell Mason's musical teachings, which set the basis for music education in America, were based on European – specifically German musical styles, at the exclusion of the musical expressions of the many other groups inhabiting the New World. (Volk, 1993).

The spread of music curriculum into schools across America was also aided by popular belief which contended that music instruction led to increased brain functioning and development of intellect. Music training was also alleged to instill good work habits, conduct, morals, and home life (Brophy, 1992). Other factors that influenced the growth of music curriculum in schools included an increased number of teachers trained through the singing schools and singing societies, the establishment of symphony orchestras in the United States, appearances by international touring musical artists, and, after the Civil War, the establishment of regimental and concert bands (Ables et al.,1984).

By the early part of the 19th century, music became integrated into public school education with an emphasis on formalized, scientific approaches to the study of vocal music (Brophy, 1992). By the end of the 19th century, Pestallozzian educational methods dominated music education. Sunderman (1971) stated, that through Pestalozzi, "music became subject matter, it was something to be studied…..music became intellectually enslaved instead of being emotionally liberated for enjoyment. Music entered the curriculum because it was a mind trainer" (p.44).

The 20th century

During the 20th century, progressive, constructivist educational philosophers once again changed educational practices and guided the focus of music education in the schools away from scientific emphasis, leading to more flexible and varied curriculum. The philosopher and educational reformer John Dewey asserted that children learn through interacting, experimenting and solving real-life problems. He argued that education should be child-centered and should start with considering the interests and needs of the child (Dewey, 1997). Jean Piaget also believed that children learn through interaction with the environment. He asserted that children construct their own meaning through play and active engagement in the world around them (Singer, D. & Reverson, 1997). Aesthetic appreciation won out over scientific value in public sentiment, and music came to be viewed as something valuable to students' personal development, to be enjoyed and appreciated. (Brophy,1992). The integration of instrumental music into music curriculum, and the rise of instrumental music in high schools in the early twentieth century, resulted from the new philosophies towards education and music

instruction during this period (Keene, 1982). Constructivist philosophies continue to influence research in music education to the present day.

Although progressive educational philosophies gained significant ground, scientific views toward education prevailed. The launching of Sputnik I in 1957 and the Soviet threat helped to change educational mentality back towards scientific discipline and away from child-centered approaches (Keene, 1982). As America strove to compete in a technological and global society, curriculum in public schools became geared towards math and science and standardized testing. As a result, music received less time in the school day schedule and the role of music, as well as other arts in educational curriculum became tenuous (Ables et al.,1984).

Despite the national trend away from the pursuits of arts education, two meetings attended by professionals interested in the future of music education, helped to secure the place of music in the public school curriculum. One of the first conferences in arts education supported by the federal government, the Yale Seminar, took place in June of 1963. (Ables et al.,1984). With a panel appointed by President Kennedy, the Yale Seminar members set out to improve public school music education and tackle some of the problems it faced. Mark & Gary (2007) explained that, “Some of the panel members expressed reservations about the heavy emphasis on the sciences in the emerging school curriculum. They felt that a serious study of the arts and humanities would enhance excellence in science, and that students would be stronger in science if they were exposed to a view of human experience as seen through the arts. The panelists believed this because so many successful scientists were also accomplished musicians” (p.399). The Yale Seminar succeeded in generating an atmosphere open to change in curriculum and

teaching styles and promoted the belief that music facilitated an understanding of the sciences. (Mark & Gary, 2007).

With the objective of defining and improving the role of music education in modern American society, the Tanglewood Symposium, sponsored by the Music Educators National Conference, took place July 23rd to August 2nd of 1967. The Tanglewood Declaration, a summary and outcome of the symposium, requested music be placed in the core public school educational curriculum. The Declaration also asserted that music curriculum should be expanded to include the music of all periods and forms as well as all cultures and styles in America. (Mark & Gary, 2007).

In 1965 music education was given an additional boost when President Lyndon Johnson passed the Elementary-Secondary Education Act. This act brought cultural enrichment programs to schools. These programs provided musical performances and workshops, as well as funding for financially struggling schools to purchase musical equipment. As the United States surpassed the Soviets in the space race, math and sciences were given less emphasis, allowing more room in the curriculum for music instruction. (Ables, et al.,1984).

In 1974 a recession brought a near halt to the advancements brought to music education. A decline in school enrollments along with decreased funding caused a profound reduction in the time and staffing given to music. A back to basics movement again popularized the emphasis on academic subjects such as math and English. Although music education faced set backs, it remained part of the classroom curriculum (Ables et al., 1984).

Recent History

In more recent history, researchers and educators continued to be interested in the relationship between music and learning. In 1983 Howard Gardner's Theory of Multiple Intelligences gave birth to a new way of thinking about learning. When Gardner (1983) positioned musical intelligence as one of only eight major intelligences, he elevated the status of musical learning in the eyes of the public and supported the use of music to facilitate learning. New research examining the relationships between music and learning began to emerge. Research by Rauscher and Shaw in 1993 coined the term Mozart Effect with studies examining the effects of Mozart's music on children. The result of this study captured the attention of a public eager to believe music to be beneficial to learning, and spawned an influx of studies further exploring the relationships between music and learning. Consequently, further studies investigated the relationships of music to standardized testing and IQ, the effects of music participation on memory development, literacy, and mathematics, and the natural relationships that children have with music in their lives. While some of these studies sought to justify the use of music curriculum through scientific means, others sought to explore how music in itself created meaning for children and facilitated learning and development by tapping into children's own inclinations and prior knowledge.

Summary

This overview of the historical development of the integration of music into public school curriculum reveals that, while humans have acknowledged the relationship between music and other areas of the intellect for many centuries, the role of music in public school curriculum experienced instability. As far back as ancient Greece, humans

have contemplated the benefits of music to the human intellect. The philosophers of ancient Greece and the Middle Ages understood the importance of music to the intellectual and emotional life of humankind, as well as the relationship between music and the laws of mathematics. Formalized music training came to America as a means to train psalm singers for the church. Music became integrated into the public school curriculum first in Boston with the introduction of Pestalozzian teaching principles. The music teaching style that spread across America was based mainly on German musical style with an emphasis on the formalized, scientific study of music. In the 20th century, progressive educational philosophies brought a more flexible attitude towards music instruction and an acceptance of music instruction in school curriculum as a valuable component of a student's personal development. In 1957, the Soviets launched Sputnik I sparking the space race, and Americans once again became concerned with scientific curriculum. The emphasis on science, math, and standardized testing, took time and money away from music curriculum. In the 1960's, however, a number of events helped to solidify and expand the role of music in public school. The Yale Seminar, the Tanglewood Symposium, and President Lyndon Johnson's Elementary-Secondary Education Act succeeded in bringing new teaching styles and curriculum, with an acceptance of music from different cultures, periods, and forms, to a wider range of students across America. In 1974 a recession and the back to basics movement once again swung the pendulum towards the basic academic curriculum of math, reading, and science. Theories such as Howard Gardner's *Theory of Multiple Intelligences* In 1993 and studies such as Rauscher, Shaw, and Ky's Mozart Effect gave the public renewed interest in music as an asset to learning and spurred interest in the relationship between music and

the intellect, including brain research that investigated the affects of music on brain development.

CHAPTER THREE: CRITICAL REVIEW OF THE LITERATURE

Introduction

Chapter one of this paper presented the question: What can recent research tell education professionals about how music participation can enhance academic achievement, cognitive development, and environments in school? In an educational atmosphere that limited the time and resources for music education this is an important question to reflect upon, especially when considering the diverse body of student needs that current educators will face. Chapter two explained that while humans contemplated the relationship between music and the intellect for many centuries, music education in the public school environment became subject to educational and philosophical currents which at times validated its role and at other times took resources and time away from it. In the last decade, a growing research base explored the affects of actively learning and participating in musical activities, as well as listening to music, on cognitive development, academic achievement, and the promotion of productive and meaningful educational environments. This chapter will explore and critique this research base. Chapter four will synthesize the findings of the research presented in chapter three, explore implications for the use of music in public schools based on these findings, and give suggestions for further research.

This chapter includes five sections that demonstrate the different approaches to research on the relationship between music and learning. These sections are: standardized testing and IQ, memory, literacy, mathematics and spatial temporal reasoning, and music in the classroom. Each study is analyzed for its strengths and weaknesses, and examined

to determine the validity of claims. Together, these studies illustrate the different areas in which researchers examined the relationships between music and learning.

Working Memory and Test Performance

A number of researchers examined whether or not participation in musical activities positively affected cognitive abilities as demonstrated through standardized and IQ tests, and sought to find a relationship between musical activity and working memory. Working memory is important to learning because it allows multiple pieces of information to be stored in the brain and allows that information to be processed, organized, and replicated. Working memory is central to many complex mental processes such as problem solving, mental arithmetic, and spoken and written language. Studies have determined that individual working memory capacity plays a role in cognitive abilities and school performance (Lee, Lu, & Ko, 2007). Within the public school environment, the retention of knowledge is often assessed through standardized tests. With the current public school atmosphere of high stakes standardized testing, implications for increased standardized test scores are important. The following research studies examined the relationship between participation in musical activities, the ability to retain information, and standardized test scores.

In the first study in this section, Chan, Ho, and Cheung (1998) investigated the relationship between verbal memory and music training. Next, Lee et al. (2007) examined how working memory and music training are related. Schellenberg (2004) examined the connections between one year of music instruction and the cognitive skills of six year olds. In a related study, Schellenberg (2006) explored the relationship between the duration of music lessons and cognitive abilities, as well as the long-term cognitive

effects of music lessons. Next, Cox & Stephens (2006) investigated the association between math grade point average and cumulative grade point average and the number of music credits earned by high school students. Johnson & Memmott (2006) investigated whether the quality of the music program in a school influenced its standardized test scores. Costa-Giomi (2004) examined the relationship between piano instruction and academic achievement and self-esteem. Fitzpatrick (2006) investigated the effects of instrumental participation and socio-economic status on standardized test results. In the last study in this section, Wallick (1998) analyzed the relationship between achievement on the fourth grade Ohio Proficiency Test and strings instruction.

In their study of verbal memory, Chan et al. (1998) explored whether music training in childhood had positive long-term effects on verbal memory. Sixty female students at the Chinese University of Hong Kong participated in this study. Thirty of the participants had up to six years of musical training in a Western musical instrument prior to age 12. Thirty had no music training. Researchers matched two groups in age, grade point average, and years of education, and evaluated each participant's verbal memory. For this study, participants recalled words in a 16-word list that researchers gave orally three times. Researchers then documented the number of correctly recalled words. Next, researchers assessed each participant's visual memory using the Benton visual-retention tests which documented the percentage of ten simple pictures that the participant could draw from memory.

The participants with prior musical training consistently recalled more words than participants who did not have music training ($F(1,58) = 17.69$, $P < 0.01$). Researchers found consistent results across three trials ($F(2,116) = 274.05$, $P < 0.01$). Differences in

scores of participants with musical training (score: 7.2 out of 10) and without music training (score: 6.9) were not significant for the visual memory test. Similar results were found when participants took part in other learning and visual tests.

Because the participants of this study, now University students, took part in music lessons prior to age 12, the results offer preliminary confirmation indicating that music training may positively affect verbal memory on a long term basis. Strengths of this study include use of a control group and well normed tests for visual memory. The inclusion of a within group examination to determine the relationship between length of musical training and word retention would give further strength to this study. Investigation into other aspects of music training such as age started and length of training will also provide further evidence and refine results.

Examining working memory, Lee et al. (2007) investigated the effect of music training in a correlational study involving 40 children with a mean age of 12 years old, and 40 adult college students with a mean age of 22 years. Participants were randomly selected from two universities and from a primary school. One-half of the children and one-half of the adults had prior music training. Participants had no differences in the number of languages or dialects spoken. The parents of the musically trained and untrained students were matched in educational levels. All of the participants were given span tasks including, forward and backward span, non-word span, operational span, and simple spatial span tasks. All participants were tested individually and the tests were given in the same order for all. Forward digit span and non-word span tests measure phonological storage. Backward digit span and operation span tests measure central

executive storage. Object-only, location-only, and combined scores tests measure visual-spatial storage.

Prior to span testing, all participants took part in a tone identification test to test musical ability. Child participants with prior musical training correctly identified a mean of 9.3 out of 10 tones, while child participants without musical training received a mean score of 1.0 out of 10. Adult participants with prior musical training received a mean score of 9.5 out of 10, and adult participants without musical training attained a mean score of 0.8 out of ten. These results demonstrated that musical training resulted in significantly improved abilities in tone identification.

For this study, the researchers performed two by two Analysis of Variance (ANOVA's) for children vs. adults and musically trained vs. musically untrained. Researchers found significant effects for age and training for the forward digit span and non-word span. For backward digit span tests researchers found significant effects for age and training and Tukey HSD tests showed lower scores for the children participants without music training than the other groups (all pHs < 0.01). For operational span tests researchers found significant effects for training and Tukey HSD tests again showed lower scores for the children without musical training than the other groups (all pHs < 0.01). For spatial span tests researchers found a significant effect in object-only scores for age. Again Tukey HSD tests showed that children not trained in music had lower scores than other groups (all ps < 0.01). Children not trained in music also scored lower than the other groups in location-only scores (all ps < 0.01).

The results of this study revealed that all child participants trained in music scored higher in all span tests than non-musically trained children. These results suggested that

music training affects phonological storage, and central executive and visual-spatial storage.

The strengths of this study include random selection of participants and the use of children as well as adults to determine results. Lack of information concerning the ethnicity, as well as the educational or economic background of participants limited the ability to generalize this study to other populations.

In a qualitative, longitudinal study, Schellenberg (2004) examined whether music lessons provided benefits that lead to advancement in nonmusical cognitive areas for six year old children. In this study, participants consisted of one hundred and thirty-two, six year old children that were found through a newspaper advertisement offering free art lessons once a week. The only prerequisite for the study was that the children's families needed to have a keyboard with at least four octaves. Families from all groups had a similar income level.

The participants were randomly assigned to be part of one of four groups. Two of the participating groups were treatment groups that took part in either Kodaly voice lessons or standard keyboard lessons for one year. The other two groups were control groups that took part in either no lessons or drama lessons. The music lessons were taught at the Royal Conservatory of Music in Canada by trained music professionals. Before beginning lessons, both groups were given the Wechsler Intelligence Scale for Children-Third Edition (WISC-III), the Kaufman Test of Educational Achievement (K-TEA), and the Parent Rating Scale of the Behavioral Assessment System for Children (BASC). These tests were given again the next summer after completion of the lessons.

While WISC-III test results showed that all four groups showed a significant IQ increase ($p<.005$), the musically trained groups had greater increases in full-scale IQ than both of the control groups ($t (130) =1.99, p, .05$). Participants in the music group had an average IQ increase of 7.0 points ($SD=8.6$) and participants in the control group had an average IQ increase of 4.3 points ($SD=7.3$). The treatment group had larger score increases in 10 out of 12 subtests. The K-TEA tests revealed no reliable difference in pre to post test improvement between the musical and non-musical groups, although the music groups showed greater increases on each of the five subtests ($p<.05$). Results from the BASC showed that the music groups did not change in regards to social behavior ratings.

The overall findings of this study indicated that music lessons result in wide-spread but modest intellectual benefit. The one year duration, the number of participants, and the use of a control group to control for the Hawthorne effect lent validity to this study. The researchers further enhanced the reliability of this study because they included test scores from after the experiment and control lessons as well as prior to the lessons. This study could have been more widely applicable to diverse populations if ethnic background of the participants were indicated. Also, the fact that participants needed to have a four octave keyboard at home most likely kept the participants in a higher income range.

Schellenberg, G. (2006) conducted two qualitative research studies in order to answer the questions of how long term involvement in musical lessons correlates with increased cognitive ability for school aged children, and whether positive associations between music lessons and cognitive capacity continue after the termination of music lessons.

In the first study the participants included 147 children, six to eleven years old, 72 boys and 75 girls. The participants had varied amounts of musical training and 56 percent of the sample had a history of private music lessons. Ninety-one percent of the sample participated in out of school organized nonmusical activities. All of the participants lived in a middle-class suburb of Toronto, Canada and 41 percent had at least one parent who was born outside of Canada. Nineteen percent of the sample had at least one parent whose first language was another European language than English. Sixteen percent of the fathers and 29 percent of the mothers had a high school diploma or less, while 19 percent of the fathers and 14 percent of the mothers had a postgraduate degree or training. Seventy-one percent of the families received an annual income of $50,000 to $125,000, 12 percent of the families received an annual income of less than $50,000, and 17 percent of the families earned an annual income of more than $125,000.

At the beginning of the study, a questionnaire about music training history and other music related information was given to each family. All participants were then given the Wechsler Intelligence Scale for Children-Third Edition (WISC-III), testing childhood intelligence, the Kaufman Test of Educational Achievement (K-TEA), testing academic achievement, and the Parent Rating Scale of the Behavioral Assessment System for Children (BASC), testing social adjustment. All participants were tested in a quiet room and were given breaks between tests.

The researchers statistically compared the test scores. Findings revealed the WISC III and K-TEA scores to be higher than published averages, most likely due to the fact that the participants came from middle class, suburban families. Standard deviations were a little smaller than published averages indicating less variability in the sample than the

general population. BASC scores were lower than average on the maladaptive Behavioral Symptoms Index and higher than average on the Adaptive Skills measure. The average grade for school subjects was close to a B+ and the average grade for learning skill was Good. Correlations illustrated the need to account for potential confounding variables associated with music lessons. Music lessons were positively correlated with age, parent education, and non-musical activities. It was found that general correlations between music lessons and intellect were not found only as a result of the confounding variables measured in this study. This study indicates that there are small, general, broad, and positive associations between the duration of music lessons and intelligence. These associations related to academic performance but not social functioning.

Undergraduate students at a Toronto University participated in the second study. Participants ranged from 16 to 25 years of age and 72 percent were female. Three-fourths of the students had an average of 3.7 years of in-school group music lessons. Over one-half had an average of 7.8 years of private musical lessons, as well as 9.4 years of regular music playing. Participants had stopped musical lessons, on average, 4 years prior, and regular playing 3.3 years prior to this study. The participants were ethnically and economically diverse. Thirty six percent of the participants were not born in Canada and 40 percent of the participants spoke a first language that was not English.

At the onset of this study, participants took a questionnaire about musical lessons and playing history. They then took the Wechsler Adult Intelligence Scale (WAIS-III), to measure adult intelligence, the Full Scale Intelligence Quotient (FISQ), slightly different than WAIS-III but with picture arrangement and comprehension, and an optional subtest,

Object Assembly. This study found that positive correlations between IQ and music lessons do hold over for many years.

These two studies suggest small, general, broad, positive, and long-lasting associations between IQ and music playing. These two studies together made a strong case that a relationship does exist between music lessons and higher test scores. In these studies, more than 100 subjects were used, participants came from diverse ethnic and educational backgrounds, and potential confounding variables such as age, parent's income and education, and non-musical activities were taken into account. While a higher educational level and social status often leads to higher test scores in students, by accounting for confounding variables, this study revealed that music lessons, and not other variables such as parent's education led to higher test scores. Random selection of participants would strengthen the reliability of these studies.

Cox & Stephens (2006) examined the correlational relationship between the number of music credits that a student received and their math grade point average, and their cumulative high school grade point average. Participants in this study consisted of ninth through eleventh grade students attending regular education classes at Valley High School in Valley, Nebraska during the 2003 – 2004 school year. Two-hundred and eight students participated, 110 males and 98 females. The researchers classified sixty-six students as having some music experience, being band or choir participation. These students were put into the Some category. One hundred forty-two students were classified as having no music experience and were put into the None category. Researchers also separated students into two groups in order to distinguish those with at least two credits of music per grade level from those with fewer or no credits of music per grade level. Therefore,

group A was formed and consisted of 32 students with at least two credits per grade level, and Group B consisted of the remaining 176 students with less than two music credits or no music credits.

Cox & Stephens (2006) collected information from each student's transcript regarding sex, grade level, math grades, grade point average (GPA), and cumulative number of music credits. Math grade point averages were calculated taking weighted classes into consideration. Researchers made comparisons between the Some group and the None group and between each grade level, as well as between group A and group B. Differences between the mean math grade point averages and mean cumulative grade point averages, along with standard deviations and test significance were calculated using the statistical software package MINITAB. Also, a scatter plot was created to indicate number of music credits versus math grade point average and number of music credits versus cumulative grade point average.

Students in the Some group earned a lower mean math grade point average than students in the None group. The difference was not statistically significant. Students at the ninth, tenth, and twelfth grade level in the None group earned a mean math GPA that was a bit higher than students in the Some group, although at the eleventh grade level students in the Some group received slightly higher mean math grade point average than those in the None group. In regards to cumulative GPA, students in the Some group received slightly higher, but not statistically significant, mean scores than those in the None group. For tenth, eleventh, and twelfth graders, mean cumulative grade point averages were slightly higher, but not statistically significant for students in the None group.

A comparison of the mean math and mean cumulative scores of group A and B were also not statistically significant, with scores for group A being slightly higher. None of the above results were statistically significant. Scatter plots illustrating the correlation between the number of music credits and math GPA, as well as the number of music credits and cumulative GPA reveal a slight increase in scores as the number of music credits increase. GPA's in the lower spectrum decreased to non-existence as music credits increase.

While Cox & Stephens (2006) stated that no conclusions can be made about the effect of music on math scores and cumulative GPA as a result of this study, scatter plots revealed a slight positive trend with the addition of music involvement. This caused the researchers to also state that "these figures suggest that music credits may have a small positive effect on math GPA and cumulative GPA" (p.762). The reliability of the study became weakened due to the fact that Cox & Stephens failed to present information about participants, or account for confounding variables such as ethnicity, economic and/or social factors, and participation in other non-academic activities. The small sample size of this study reduced the relationship between music and math and cumulative GPA. Further research is needed in this area to assess whether a relationship exists.

Johnson & Memmott (2006) explored the relationship between the quality of school music programs and standardized test scores. The researchers examined test scores from 4,739 elementary school students in the third and fourth grade, and middle school students in the eighth and ninth grade from the West Coast, East Coast, Midwest, and the South. Music education faculty familiar with the quality of the music education programs at school districts in each region chose the participant schools. Anonymous student

participation resulted in no known information regarding age, gender, socioeconomic background or other factors.

The researchers obtained copies and results of standardized tests that met the requirements of the No Child Left Behind legislation for all participants. These tests encompassed six different English tests and five different math tests. The tests scores were entered into a data base and categorized. The elementary tests were separated into two groups, one group went to a school with an excellent music program, and the other group went to a school with a substandard music program. The middle school tests were separated into groups in a similar way as the elementary groups but they were also identified as belonging to instrumental students, choral students, or non-music students.

For elementary scores, all tests were first converted into comparable z-scores. Scores were analyzed using ANOVA procedures with independent variables of geographic location and music instruction quality. On the West coast student test scores in high quality music programs were lower than student test scores in inferior music programs but comparisons of the other regions indicate English test scores 24% higher in schools with excellent music programs. Math scores showed no regional differences. Differences were found; however, in differing quality music programs, $p < .001$. All of the four elementary schools with excellent music programs scored higher than schools with poor music programs. In the South and East, the difference went past a half standard deviation. Z-scores indicate that English scores were 22% better at schools with exemplary music programs than schools with lacking programs. Math scores were 20% better at the schools with excellent music programs at the elementary level.

Middle school test scores were analyzed with ANOVA procedures with region and type/quality of music program being independent variables. Type/quality of music program was split into five categories: excellent instrumental, excellent choral, inferior instrumental, inferior choral, and no music. Graphed data indicated that students with high quality music programs generally scored higher than students with low quality music programs and students with low quality music programs scored higher than students with no music instruction. Also students in poor quality choral programs had the lowest scores in all regions. Data from the West Coast and Midwest present exceptions to the data trends of high quality instructional programs. All students in low quality instrumental programs had higher scores than students with no music at all.

English test scores indicated a 19% jump in scores from no-music students to students in the high quality instrumental and choral group, and an extra 13% of the population difference to the students with inferior choral programs. This illustrates a range of 32% difference. In math the difference between the high quality instrumental and choral group and the students with no music was 17%, plus an extra 16% difference from the inferior choral group. The range encompassed one complete standard deviation, which covered 33% of the population in the difference.

This study suggested that there is a strong relationship between high quality music programs and higher test scores. The study did not assert causation however. A major flaw of this study is that it did not account for the fact that high quality music programs may likely reflect a high quality school with high quality English and math programs. The study indicated a need for further investigation in this area.

In another longitudinal study, Costa-Giomi (2004) researched the effect of piano instruction on academic achievement and self-esteem of fourth grade students. One-hundred-seventeen students in the fourth grade who attended public school in Montreal participated in this study. Participants had no prior formal music instruction and no piano at home. Participant families earned an annual income below $40,000 Canadian currency. Thirty percent of the participants lived with a single parent and close to 25 percent lived with unemployed parents.

One-half of the students took part in the treatment group. Each of these students received free piano lessons for three years and an acoustic piano in their homes for free. Researchers placed the other half of the students into a control group that did not receive lessons or a piano. A third group formed during the life of the study which consisted of students in the treatment group who stopped taking lessons but completed all of the necessary testing.

Prior to the piano lessons, all students took standardized tests in the areas of mathematics, language, musical aptitude, fine motor skills, self-esteem, and developing cognitive abilities. Test results indicated that the treatment group and the control group had equal test results. After the first, second, and third years of the study, the students were retested with tests appropriate to grade level. Researchers also evaluated student report cards beginning from the year before the study began until the end of the study. In this way they were able to monitor overall performance over these years.

Findings of this study revealed that participation in music instruction did not have an effect on academic achievement in math and language, according to grades and

standardized test results, but it did have a positive effect on children's self-esteem and school music grades.

This study and its results bring into question whether any causal relationship exists between academic achievement and formalized music instruction. While the three year extent of this study gave reliability to the results, other factors weakened reliability. The study did not provide information on the ethnic background of participants, therefore, this study can not be applied to specific populations. The lack of any lessons provided to the control group weakened the study results and made it impossible to determine whether the benefits to self-esteem were due to extra attention the participants received from the piano teacher, parents, and peers, as well as the opportunity to develop a new talent, or to the music lessons themselves. As a follow-up to this study, researchers could examine the long-term relationship between self-esteem and grades and test results.

Fitzpatrick (2006) examined the relationship between instrumental music participation, socio-economic status, and performance on standardized tests in a correlational study involving ninth though twelfth graders attending public school in Columbus, Ohio during the 2003-2004 school year. Out of the 15,421 participants, 915 were involved in instrumental music classes, band, orchestra, or jazz ensemble and 14,516 were not enrolled in an instrumental music class. Instrumental and non-instrumental students were placed in separate data bases. All students were also separated into four groups to account for social and economic status. These groups were: instrumental music students receiving free lunch, instrumental music students paying full lunch price, non-instrumental students receiving free lunch, and non-instrumental students paying full price.

Students in the state of Ohio in fourth, sixth, and ninth grades are required to pass the Ohio Proficiency Test in reading, writing, math, science, and citizenship. Because the study examiners wished to look at results across time, they obtained test results from the fourth, sixth, and ninth grades for students in ninth through twelfth grade. Different administrations of the same tests within the Ohio Proficiency Test were scaled for difficulty so that they could be comparable. Scores used were reading, math, science, and citizenship. Writing scores could not be used because they were not graded by a computer and therefore, could not be scaled. Comparisons were made between instrumental students and non-instrumental students of like social and economic status.

Full price instrumental students scored the highest on seven of the twelve tests examined. Due to this, researchers analyzed scores from the different social and economic groups separately. Analysis revealed that all students that would become instrumental students in high school received significantly higher scores before music instruction began, than future non-instrumental students of similar socioeconomic status ($p<.05$). Also instrumental students outscored non-instrumental students of like socioeconomic levels in all subjects and grade levels with a $p<.05$ level of significance for all tests except sixth grade math scores between free-lunch instrumental music students and free-lunch non-instrumental music students. Full priced lunch instrumental students scored the highest of all groups for each subject and grade level. Free or reduced lunch non-musicians performed the lowest. While for the majority of the grade levels, students of higher social and economic status scored higher than those of low social and economic status, test results for the ninth grade indicated an exception. Fourth grade students receiving free or reduced lunch that would become high school instrumental

students received higher mean scores than those of non- instrumental students receiving free or reduced lunch assistance, but lower scores than instrumental and non-instrumental full priced lunch students in the areas of math, citizenship, and science. Fitzpatrick (2006) stated that, “This achievement gap was to be expected when considering the previously described strong relationship between SES and academic achievement” (p. 75). In sixth grade free and reduced priced lunch instrumental students still received lower scores than full priced instrumental students and non-instrumental students. Ninth grade scores revealed that the free and reduced lunch instrumental students received higher scores in math, citizenship, and science than full priced lunch non-instrumental students. These results indicated that music involvement may have positive implications for students with lower economic backgrounds.

The results of this study revealed higher test scores of instrumental students than non instrumental students across all grades and subjects, supporting the conclusion that musicians received higher standardized test scores than non musicians. However, the fact that participants who became instrumental students in high school received significantly higher test scores before beginning music instruction, suggested that higher achieving students are attracted to music classes. This, in turn, suggested that music was not responsible for the higher grades. Further research is needed to determine whether the improvement in scores of low social and economic status instrumental students was due to music participation.

In a correlational study, Wallick (1998) investigated the effect of strings instruction on fourth grade achievement on the Ohio Proficiency Test. Wallick ability-matched one hundred forty-eight string students (SS) in the fourth grade with one hundred forty-eight

non-string (NS) students according to the scores received on the verbal portion of the Cognitive Abilities Test. He then documented and compared the scores of the Ohio Proficiency Test of strings and non-strings students. Participants from 12 out of 13 elementary schools in the Hamilton City School District, located in a predominantly blue-collar middle class community in southwestern Ohio, were matched with other students from their own school. Participants came from culturally and socio-economically diverse backgrounds.

Strings students were pulled-out of class for thirty minutes, twice a week to participate in their regular strings instruction. Scores from the Cognitive Abilities Test (COGAT) and the Ohio Proficiency Test (OPT) were collected and compared.

Wallick (1998) performed two-sample, matched-means t-test on the OPT scores in mathematics, reading, writing, and citizenship. Mean scores of the string students were higher than mean scores of the non-string students in all areas of the OPT. No significant difference was found in the areas of writing and mathematics but string students scored significantly higher in the reading and the citizenship areas than the non-strings students. Wallick noted that "68% of SS were able to perform at standard on all four sections of the OPT, while only 58% of NS passed all four sections."

The results of this study revealed that strings students received scores that were significantly higher than the non-string students on the reading and citizenship sections of the OPT. Also, strings students received no negative effects as a result of being pulled-out of their regular classroom for strings instruction. Wallick (1998) stated that more empirical evidence is needed to understand the variables that may have been responsible for the enhanced achievement by strings students. There was no accounting for the

different environments of the 12 different schools that participants attended so it is difficult to determine whether the effects were due solely to strings instruction. Nevertheless, this study produced a strong relationship between pull-out strings instruction and standardized test scores.

This section began with two studies that investigated the relationship between music participation, memory, and cognitive development. Chan et al. (1998) established a preliminary positive relationship between music participation and verbal memory. Lee et al. (2007) found a relationship between music participation and working memory, specifically phonological storage. These two studies determined a small and preliminary relationship between music participation and memory. There is more research to be done in the area of music and memory. According to Jensen (2000) children retain information more readily when participating in musical activities. Further studies in this area will determine instructional tools that may be useful in facilitating memory development. Schellenberg (2004) found modest associations between keyboard and voice training, and enhanced cognitive skills, although these can not be generalized to other populations. Schellenberg, G. (2006) revealed a small yet long term relationship between the duration of music lessons and cognitive effects. Cox & Stephens (2006) found only a slight trend between the number of music credits received and grade point averages. Johnson & Memmott (2006) investigated the relationship between standardized test scores and the quality of a schools music program and found no significant relationship. The weak design of the prior two studies further limits their implications. In a study of low-income students, Costa-Giomi (2004) examined whether piano instruction influenced academic achievement and self-esteem of low-income populations and found positive results only

for self esteem. Fitzpatrick (2006) conducted a study of the relationship between standardized test scores, instrument training, and socio-economic status. Analysis determined that future music students received higher test scores before music instruction began, and that scores of low-income students increased throughout music instruction. Wallick (1998) found a positive relationship between strings instruction and standardized test scores. These studies taken together indicated a small relationship between participation in musical activities and increased memory and cognitive skills as assessed by standardized tests. These findings had positive implications for low-income populations.

Literacy

A strong need exists to develop effective teaching strategies in regards to literacy. The 2003 National Assessment of Educational Progress report demonstrated that close to 40 percent of students throughout the United States cannot read even at a basic level, and that by fourth grade 37 percent of students cannot understand simple paragraphs. Studies have also indicated that students who do not learn to read in primary school often do not learn to read later in life (Perret & Fox, 2004). Hill-Clarke & Robinson (2004) stated that children utilized a variety of reading styles, therefore it is appropriate to utilize a variety of teaching strategies. The National Reading Panel, as part of the No Child Left Behind Act, however, instigated greater accountability for schools to meet literacy goals demonstrated through high stakes testing. An emphasis on meeting these goals caused curriculum to be narrowed, often at the cost of music and other arts (Curtis, 2007).

Recent research supports the use of music to facilitate learning literacy. Strategies used in literacy development are also used in music training. These include recognition of printed letters and symbols, concepts of print, and an understanding of sequence (Register, Darrow, Standley, & Swedberg, 2007). Curtis (2007) noted that music and reading both use a system of written symbols to express meaning. “When placed together letters form words: notes can form chords. Words are placed together in a meaningful order to make a sentence. Notes are placed in a meaningful order to form a measure, or even a phrase” (p.16). Researchers also found relationships between musical training and phonemic awareness (Gromko, 2005). Phonemic awareness is one of the strategies that may be used to teach literacy to readers from kindergarten through second grade. The educational philosopher Lev Vygotsky asserted that language is a powerful means

through which children learn (Curits, 2007). Music participation can assist children to understand their world and gain the literacy skills so greatly needed in today's world.

The studies in this section illustrated how musical training facilitated literacy development. In the first study, Butzlaff (2000) performed a meta-analysis that investigated the relationship between music training and reading performance. Next, Gromko (2005) examined whether music participation had an effect on the phonemic awareness of kindergarten students. Register (2001) examined the relationship between prereading and prewriting skills and music therapy curriculum. Register et al. (2007) examined the relationship between music curriculum and vocabulary and reading comprehension skills. Finally, Curtis (2007) examined the ways that music and literacy could be integrated in the regular classroom and the music classroom.

Butzlaff (2000) examined the relationship between reading performance and music instruction in a meta-analysis of the empirical literature investigating that topic. Thirty research studies were chosen according to the following criteria: a standardized measure of reading performance was used, music instruction was followed by a reading test, and statistical data provided was sufficient enough to estimate an effect size. Twenty four of the studies were determined to be correlational and six experimental.

The largest ten studies in the correlational group were carried out by the College Board and took place from 1988 to 1989. These studies, which had sample sizes over 500,000, examined the relationship between involvement in music classes in high school and verbal Scholastic Assessment Test (SAT) scores. The other correlational studies presented in this meta-analysis examined associations between instrumental music

classes, including Suzuki violin and music instruction by the regular classroom teacher, and scores on other reading tests including the Stanford Achievement Test.

The group of experimental studies analyzed included six studies which utilized different types of music instruction, including singing, learning notation, and keyboard instruction. Each study used a pre and post test and randomly assigned students to the experimental and control groups. All of these studies used a different standardized test to measure reading performance. The effect size for these experimental studies varied from .34 to .64.

Results of the meta-analysis of correlational studies revealed a relationship between positive scores on standardized tests in reading and active music instruction. Results of the Stouffer's Z, along with a t test of the mean Zr both showed significant results ($Z = 301.38$, $p < .0001$ and $t = 4.2$, $p < .001$). Results of the meta-analysis of experimental studies revealed a positive effect size ($r = .18$ or .11 weighted according to sample size) as well as a consistent Stouffer's Z ($Z = 2.38$, $p = .009$).

This meta-analysis brought moderate support to the argument that music involvement enhances reading performance. The College Board group of correlational studies showed positive correlations between music involvement and SAT scores (.16 to .22). Butzlaff (2000) stated, however that causality cannot be asserted from the correlational studies. While these correlational studies do reveal an association between music involvement and high scores on standardized reading tests, they do not reveal an explanation for this phenomenon. Another limitation is that the students were not pretested in these studies. Considering these two factors, researchers could not determine whether music involvement held responsibility for the increased scores.

In a quantitative study, Gromko (2005) researched the relationship between music instruction and significant improvement in young children's development of phonemic awareness, specifically in relation to phoneme – segmentation fluency, and asked whether learning to analyze the patterns of a simple song led to greater competence in segmenting words into phonemes.

Participants of this study included kindergartners from two different elementary schools in the Midwest. Forty-three students from one school took part in the treatment group and sixty students from the other school took part in the control group. Approximately 20 percent of the students from the treatment group qualified for the free-lunch program and approximately ten percent of the children in the control group did.

Kindergartners in the treatment group were taught music instruction by advanced-methods university music students for 30 minutes a week for four months. They were taught how to sing a folk song and accompany it with body or instrumental percussion, or kinesthetic movements. While singing, the children were asked to touch a graph with symbols representing steady beats, word rhythms, melodic contour, and others aspects of music. Kindergarteners in the control group did not receive music lessons or any lessons other than the regular kindergarten curriculum.

After four months, students from both schools were tested on letter-naming fluency, phoneme – segmentation fluency, and nonsense word fluency.

The results of the data generated by this study indicated that students who had four months of music instruction demonstrated greater gains in phoneme – segmentation fluency than students who received no music instruction. (p= .001) Treatment group (Mean=26.12, SD=16.05). Control group (Mean=15.72, SD=13.83). Letter naming

fluency means gain scores for the treatment group were not significantly greater than for the control group.

The results of this study provided support to the claim that music can facilitate learning in the area of literacy. The scores of the students in the treatment group improved significantly more than the scores of the control group in the area of phoneme – segmentation fluency, from pre to post test. Gromko (2005) noted that other factors besides music instruction may have influenced this improvement. She asserted that "if there were systematic differences in the reading instruction at the treatment and control schools, then the differences in the development of phoneme – segmentation fluency could be attributed to differences in reading instruction at the schools" (p.206). She suggested that future researchers should randomly assign students from different schools to the control group and the treatment group. The assignment of an extra curricular activity to the control group would further strengthen this study by determining whether other extra activities besides music positively affect literacy.

While these limitations are valid, they did not account for the fact that the only significant gain of the treatment group over the control group in the study was in the area of phoneme – segmentation fluency, the focus of this study, and not in letter-naming or nonsense-word fluency. This suggests that the near-transfer theory could account for the improved scores. Gromko stated that, "Although readers should interpret these results with the limitations of this study in mind, I believe that these results have sufficient credibility to serve as the basis for continued inquiry into near-transfer effects of music instruction" (p. 207).

Register (2001) investigated the effect of music therapy curriculum on prereading and writing skills in a quantitative experimental study involving 50 participants four to five years of age. Twenty-five of the participants took part in the experiment group and 25 took part in the control group. Both groups had 14 females and 11 males. Participants came from two different schools and four prekindergarten classes, including Early Intervention programs as well as programs for exceptional students. Each school had an equal number of students in the control group and the experimental group. Twenty-four of the 25 students in the experimental group took part in an EL program and eight received services for speech disorders. In the control group, 23 students received EL services and seven students received speech services.

Both groups received two 30 minute lessons a week over a period of 30 weeks. The experimental group took part in music therapy lessons specifically created to reinforce and teach prereading and prewriting skills. During the initial fifteen weeks of the study, students in the experimental group drew pictures in their journal about something that they did in music class. The students then dictated an explanation of the drawing which the teacher or paraprofessional wrote on the picture. During the next 15 weeks, students learned one song a week. They drew illustrations for the songs and they created a song book made up of a number of the songs learned in music class. The control group took part in music therapy lessons which stressed development of socialization, cognitive skills, and movement. They did not do any pre-reading, writing, or drawing activities.

Register collected all of the post-music lesson work and assessed written language skills using the Developmental Writing and Language Skills Checklist. She pre and post tested the experiment groups and the control groups using three tests. These tests

included The Print Awareness Test for Logos, the Print Awareness Test of Word Identification, and the Print Concepts Checklist.

Pre and post tests were compared with a two-tailed paired sample t-test. No significant differences were found between the experimental group and the control group on the Logo Identification pretest ($t = -1.61$, $df = 24$, $p < .05$). For this same test, researchers found a significant difference between the pre and post tests of the experimental group and the control group, with the experimental group receiving significantly higher improvement ($t = -2.878$, $df = 24$, $p<.05$). For the Print Awareness test, no significant difference between the experimental group and the control group on the pretest appeared ($t = -0.101$, $df = 24$, $p<.05$) and again researchers found a significant difference between pre and post tests for both groups with the experimental group attaining significantly higher improvement ($t = -5.319$, $df = 24$, $p<.05$). The Concepts of Print test revealed a significant difference between pretest scores with the experimental group scoring higher than the control group ($t = -2.449$, $df = 24$, $p <.05$). While no significant difference was found between the pre and post tests for the experimental group ($t = -0.104$, $df = 24$, $p <.05$), the control group scored significantly higher on the post tests than on the pretest ($t = -5.794$, $df =24$, $p <.05$). This result may be due to the fact that the experimental group initially had higher scores. Also a comparison between the differences in pre and post test scores of the experimental group and the control group indicated no significant difference ($t = -1.993$, $df = 24$, $p <.05$).

Irregularities in teacher implementation of journaling activities as well as student attendance led researchers to choose 3 class periods for further analysis. From each class period, researchers randomly selected one song sheet and one picture from each student.

Researchers compared the scores on the Developmental Writing and Language Skills Checklist that corresponded to the song sheet and pictures of the three periods using a One-Way ANOVA. Results performed on post-hoc Tukey HSD tests on the means for the song sheets and the picture revealed no significant differences between the three post session drawings. Significant differences were found between Song Sheet one and Song Sheet two ($p<.02$) and Song Sheet three ($p<.001$). Song Sheet two and Song Sheet three did not reveal significant difference ($p<.05$). Register (2001) stated, "These results reveal that more progress in developmental writing took place during the earlier sessions of the study. While these results showed progress across time, the progress cannot be completely attributed to the music as there was no comparable measure performed for the control group" (p.246).

Results of this study provided some support to the argument that integrating music into literacy curriculum may play a beneficial role in improving the prewriting skills and print concepts skills of pre-kindergarten students. The experiment group experienced significantly more improvement than the control group on the Logo Identification test and the Word Recognition test. The study offered no information about the economic or social status or the ethnicity of the participants. For a more in-depth analysis, researchers could investigate correlations between the progress of participants attending the early intervention programs and those enrolled in programs for exceptional students, as well as ESL students and students attending speech therapy.

In a quasi-experimental, quantitative study Register et al. (2007) examined whether music curriculum can effectively improve the vocabulary and reading comprehension of second graders and students with reading disabilities. Participants of this study included

33 second grade students and eight students with reading disabilities. Two second grade classes were randomly assigned to a control group with 16 students, and a treatment group with 17 students. Students with disabilities took part in the treatment group only.

Students in the treatment group took part in their regular music curriculum along with a music/reading program that focused on word knowledge, word decoding, and reading comprehension, skills encompassed within most standardized reading tests. Each lesson included music listening, singing, instrument playing and movement. The control group took part in the regular reading program only.

The treatment group received three lessons a week over a four week period. These lessons were designed to engage students through incorporating different types of activities to appeal to different learning styles. Sound and visual materials such as instruments and puppets were used to support learning. Each reading lesson incorporated at least one music lesson to teach and practice a reading strategy. Some examples of musical activities included singing songs and identifying context clues to define words within the song, and practicing sequencing events by singing a song and placing story cards that related to the story told in the song in the correct order.

Students in the treatment group and the control group took the vocabulary and reading comprehension subtests of the Gates-MacGinities Reading Tests before and after the treatment period. Comprehension subtests included Word Decoding, Word Knowledge, and Reading Comprehension.

Researchers analyzed the tests of students with reading disabilities using paired t-tests and Wilcox signed rank tests. Due to a small number of students with learning disabilities, reliability of findings was ensured with parametric and nonparametric

analysis. The following results indicated that test scores improved significantly after treatment: word decoding: p = .04, word knowledge: p = .01, reading comprehension: p = .01, test total: p = .01. Findings were corroborated by a paired t-test with the following results: word decoding: p = .05, word knowledge: p = .00, reading comprehension: p = .00, test total: p = .001.

For second grade classes the test results indicated that the treatment group and the control group both had improved test results. For word decoding (treatment: p = .00, control: p = .01), word knowledge (treatment: p = .00, control: p = .00) and test total (treatment: .00, control: p = .00), results were significant. For reading comprehension (treatment: p = .20, control: p = .18) results were not significant. A Univariate Analysis of Covariance (ANCOVA) showed that improvements made by the treatment group were greater than improvements made by the control group, however; only word knowledge showed significant difference (p = .01).

The results of this study indicated that students with reading disabilities had significantly increased scores in word decoding, word knowledge, and reading comprehension. However, the lack of a control group and the small sample size of students with reading disabilities diminished the usefulness of this study. From this study it is impossible to determine whether the increased scores were due to music participation or to maturation. The results from the second grade group were more substantial due to the presence of a control group. While both the treatment group and the control groups showed improved scores from the pretest to the posttest, results indicated that the treatment group's scores in the area of word decoding improved significantly over the control group's scores. The relatively small sample size and the lack of knowledge about

the socio-economic or ethnic background of the participants discourage generalizing this study to other classroom populations. Despite these limitations, Register et al. (2007) offered modest evidence that music can effectively be used to enhance reading curriculum, particularly in the area of word decoding, for second grade students. More research with larger sample sizes, with students with learning disabilities, and with diverse participants is needed to strengthen their argument.

In a qualitative observational case study Curtis (2007) examined how music could be integrated into a kindergarten classroom to enhance early literacy learning. During this study Curtis observed a full day kindergarten classroom with 18 students, nine girls and nine boys, for a period of nine weeks. The students attended an elementary school in a town with a population of around 4,000. The town was situated 30 minutes from the state capital, in the rural Midwest. Four students in the classroom were classified as low-socio-economic level. Seventeen were Caucasian with one multi-racial student. One child received special education services and several received speech support.

Curtis chose the classroom for this study due to the teacher's history of using music in the classroom. Students in this classroom received reading instruction for 90 minutes. They received 20 minutes of music instruction a day in a music classroom with a qualified music teacher. Curtis observed the students in the regular classroom environment and in their music classroom from February 15th through April 23rd, 2007. Her observations ranged from 50 minutes to 3 hours a day, culminating in a total of 42 observation hours.

Curtis gathered data through observations, interviews, audio-visual materials, and documents. Her notes included a description of the participants and the physical setting,

as well as detailed descriptions of critical dialogue and events and activities that occurred. Curtis conducted interviews with the classroom teacher, the music teacher, and the students. She video-taped a number of classroom lessons during which read-aloud, guided reading, role playing, singing, and/or music sessions took place. She established trustworthiness through prolonged engagement and persistent observation, rich description, peer review and debriefing, clarifying researcher bias, and member checks.

Upon analyzing her data, Curtis found that music was used as a learning tool in the music classroom as well as in the regular classroom throughout the school day. Music was used as a way to facilitate transitions from one activity to the next and it was used to teach and review content in all academic areas. Curtis found a number of practices, teaching techniques, and materials that were utilized by both the classroom teacher and the music teacher. These were a gradual release of responsibility, the use of metacognition, sharing of quality children's literature, development of oral and written language, and active engagement in learning/gesturing. Her data revealed that music was integrated with literacy in the regular classroom as well as in the music classroom, in the areas of phonemic awareness, phonics, vocabulary, fluency, and comprehension, and concepts about print. Curtis described an example of Comprehension practice in the regular classroom as, "Teacher stops during a read-aloud story/song, There Was an Old Lady Who Swallowed a Shell, and asks students to predict what will happen next to the main character." (p.156). She described an example of Vocabulary practice in the music classroom as, "Teacher asks students to listen to classical music and then tell of words they could use to describe what they heard." (p.155). In interviews, students made positive comments about music in their lives and the use of music in school.

Due to the results of her study, Curtis stated that, “Music was used in the kindergarten classroom to deliver content, to explore rhythm and rhyme of language, to provide opportunities for listening comprehension, and to allow children to respond aesthetically throughout movement.” She came to the conclusion that music “is a crucial component of effective literacy instruction” (p.211).

This study illustrated how the relationships between music and literacy can be effectively implemented within the regular classroom as well as the music classroom to enhance the learning experience. The results of this study may not be generalizable to other populations due to the small sample size, and the concentration on one school with a teacher that already used music as an instructional school. Quantitative data may further solidify results and determine whether or not literacy progress improved as a result.

The studies in this section indicated that a relationship does exist between music instruction and literacy skills. Butzlaff (2000) established a modest relationship between music training and reading performance. Gromko (2005) found a relationship between music participation and increased phonemic awareness in kindergarten children. Register (2001) established a positive relationship between the integration of music therapy and prereading and writing instruction and enhanced logo identification and word recognition. Register et al. (2007) found a modest relationship between music participation and reading skills. Curtis (2007) revealed how music and literacy can be integrated into the classroom community to facilitate learning.

Math and Spatial Skills

Researchers investigated how music and cognitive areas involved in mathematics are related. Rauscher (2006) explained that playing a musical instrument involved skills that may be transferred to other activities. Similar to the relationships explained in the literacy portion of this paper, musical relationships can be transferred to mathematical relationships. For example, musicians need to learn how to divide and subdivide rhythms in the same way that the mathematician will divide numbers into parts and wholes. Bilhartz, Bruhn, & Olson (1999) asserted that musical activity utilized neural firing patterns in the brain identical to those used in activities which involve spatial-temporal reasoning. According to Bilhartz et al. (1999), spatial-temporal reasoning "is a process that requires mentally maintaining images without the assistance of a physical model and then transforming and combining these images in a way to make a meaningful whole" (p. 616). Spatial-temporal reasoning is used in engineering, chess, higher mathematics, proportional reasoning, and in music (Grandin, Peterson, & Shaw, 1998). Brochard, Dufour, & Despres (2004) also indicated that music enhances visuospatial abilities, processes that depended on vision, including the mental manipulation of spatial relationships and stimulus recognition. These are tasks useful in mathematics as well as the sciences.

The following studies tested how music facilitates learning in the area of mathematics and spatial-reasoning. Rauscher, Shaw, Levine, Wright, Dennis, & Newcomb, (1997) analyzed the effect of individual piano keyboard instruction and group singing on the long-term spatial-temporal reasoning skills of preschool children. In a continuation of the previous study, Rauscher & Zupan (2000) examined the relationship between group

music instruction and the improvement of spatial-temporal reasoning skills of kindergarten students. Bilhartz et al. (1999) examined whether music training during early childhood led to enhanced cognitive development, specifically in the area of spatial-analytical skills. Brochard et al. (2004) investigated the relationship between musical training and long-term enhancement of visuospatial abilities. Hanson (2003) researched whether Kodaly literacy- based music instruction would facilitate improvement of the spatial and verbal skills of kindergartners. Graziano, Peterson, & Shaw (1999) investigated whether students' spatial-temporal reasoning skills would benefit from keyboard training mixed with training in a math video game developed to teach spatial-temporal reasoning skills. Vaughn (2000) examined the effects of music listening and instruction on mathematical achievement. Hetland (2000) investigated the relationship between music instruction and spatial reasoning skills.

Rauscher et al. (1997) investigated whether individual instruction on piano keyboards, supplemented by group singing caused long-term enhancement of spatial-temporal reasoning in preschool children. Seventy-eight participants, 42 boys and 36 girls aged three to four took part in this study. Participants came from three different preschools, were of normal intelligence and were ethnically diverse.

Researchers tested the spatial-temporal and spatial recognition skills of participants using the Wechsler Preschool and Primary School Scale of Intelligence-Revised (WPPSI-R), which included Object Assembly, Geometric Design, Block Design, and Animal Pegs. Of these four tasks, only Object Assembly measures spatial-temporal skills, the others measure spatial recognition.

Participants were given keyboard lessons along with casual singing lessons (n=34), casual singing lessons alone (n=10), computer lessons (n=20), or did not receive lessons (n=14). While some groups were randomly assigned, others were not, due to previously assigned classes. During the two year study, participants took part in lessons either once a week for six consecutive months or twice a week for eight consecutive months. Students in the keyboard group were taught by a professional keyboard instructor. They took part in 10 minutes of traditional keyboard instruction that focused on music notation, pitch interval, fingering, sight reading, and playing from memory. The students had one hour of practice time available to them at the school. They also took part in thirty minutes of singing lessons on a daily basis. The singing group took part in these singing lessons but did not receive keyboard instruction. The computer students received computer lessons for ten minutes a day, during which a professional computer instructor gave them instructions in using a computer and utilizing reading and mathematics software. This group was set up to control for the Hawthorne effect, as well as hand-eye coordination. The no lesson group did not take part in any lessons.

Upon analyzing data the researchers performed a one-way ANOVA on the different groups. They conducted a Bonferroni adjustment to insure that findings were not due to error or chance. Results revealed that the students receiving keyboard training significantly improved their scores on Object Assembly from pre to post test (mean pre-test = 9.8, mean post test = 13.41, $p<.001$). Students in the Singing, Computer, and No Lesson groups showed no significant improvement from pre to post test. The differences between pre to post test improvement of the keyboard group and the other groups were not significant.

Spatial temporal reasoning scores for the post test were significantly higher for the keyboard students than for the students in the other groups, who exhibited no significant improvement in the area. There was no improvement in any of the groups in spatial recognition.

The results of this study determined that the keyboard group had significantly higher scores in spatial-temporal reasoning than the control group.

The results of this study are strengthened with the inclusion of a control group for the Hawthorne effect, although the fact that the keyboard group had an extra hour of practice time and the control group did not, weakens the results. Never the less, this study demonstrated a positive relationship between keyboard training and spatial-temporal skills.

In a qualitative study, Rauscher & Zupan (2000) examined the effect of classical music lessons using the keyboard on the spatial temporal reasoning skills of kindergarten children. Participants included 62 kindergarten students, 36 boys and 26 girls, attending four kindergarten classes at two public elementary schools in Wisconsin. Participants were from middle-income families of mixed ethnicity.

Prior to the experimental treatment, participants were given two tests from the McCarthy Scales of Children's Abilities, in Puzzle Solving and Pictorial Memory, and one test from the Learning Accomplishment Profile Standardized Assessment (LAP-D), in Block Building. Participants were again given these same tests after two four-month intervals, for a total of three testing periods. Testing periods were conducted by Zupan (2000) and a colleague who was unaware of the hypothesis of the experiment.

The participants at both schools were separated into two groups, those to be given keyboard instruction, and a control group that would not be given music instruction. Participants in the keyboard group were assembled into groups of 10 students and given 20 minutes of instruction two times a week from a music specialist. They received instructions in playing the keyboard, as well as singing, movement, ear training, rhythm, improvisation, notation, and interval and dynamic exercises. While the participants in the experiment group were allowed to play the keyboard throughout the school day, participants in the control group did not have access to keyboards. Participants in the control group took part in journaling exercises in lieu of keyboard instruction.

In their examination of the findings of this study the researchers analyzed predictors including, whether the participant was in the music group or not, pretest score, sex of participant, and time, that may have been a factor in higher posttest scores. A significant correlation was found for the pretest scores (pretest: $r = -0.25$, $p \leq .05$; 4 month: $r = -0.54$, $p \leq .01$; 8 months; $r = -0.49$, $p \leq .01$). The researchers carried out a MANOVA which found significant main effects for and interaction between group and time. No other significant interactions were found.

The researchers conducted Scheffe t-tests that revealed no significant differences between variables for the keyboard and control group pretest scores and the pretest scores of the (Puzzle Solving: $t = 0.15$, $p > .05$; Block Building: $t = 0.98$, $p > .05$; Pictorial Memory: $t = 4.7$, p add .001). T tests showed that students in the experiment group received scores significantly higher on the Puzzle Solving and the Building Blocks tests after 4 months of lessons, than the students that were not in the experimental group (PS: $t = 4.90$, p add .05; BB: $t = 4.7$, p add .001). Spatial temporal task scores after eight months

revealed even higher increases in scores for the experimental group than for the control group. There were no significant differences between the group scores for Pictorial Memory.

Researchers conducted a MANOVA analysis for sex, group, and time, on each test. ANOVA's for group and time were also conducted. Researchers found a significant interaction between group and time. The researchers then conducted a MANOVA on pretest scores for sex and group that determined equivalent scores prior to treatment. A final MANCOVA for group was conducted to test preceding results.

The results of this study revealed that music instruction has a positive effect on the spatial-temporal reasoning skills of kindergarten students. The implications of this study benefit the classroom teacher because they determined that the positive results occurred in a group lesson classroom setting rather than in an individual lesson setting. The use of a control group that took part in journaling exercises strengthens the reliability of the results because positive results only occurred with music instruction. However, the lack of analysis between the different types of musical instruction made it difficult to determine whether the positive effect was caused by keyboard instruction or another type of musical instruction, or another factor.

Bilhartz et al. (1999) examined whether music training added into early childhood classroom curriculum on a weekly basis led to assessable cognitive development in nonmusical areas, specifically spatial-analytical development. Participants in this study included 71 four and five year olds living in Texas who attended one of two rural Head Start centers, four preschools in a small city, or a music center in that city. Children equally represented lower, middle, and upper income households with an equal numbers

of boys and girls. Participants included 70% white, 17% African, 7% non-black Hispanic, and 6% Asian. The experimental group included 36 children. The control group included 35 children who received no treatment . Lack of parent consent in some instances and challenges in finding participants in the targeted age group caused boys and girls to not be equally distributed between the control group and the experimental. The control group had 22 boys and 13 girls, the experiment group had 14 boys and 22 girls. Although the experimental group had an under representation of boys in middle-income earning households, the authors believed that the conclusions of the study were not compromised due to the fact that boys frequently attain better scores on tests of abstract reasoning than girls. The parents of the participants in the experiment group and the control group had no significant difference in numbers of years of schooling. Three students in the control group and nine students in the experimental group had previous music education experience.

Prior to the experiment, the participants each took a series of Stanford-Binet Intelligence Scale (SB) tests that examine cognitive abilities in vocabulary, memory for sentences, bead memory, pattern analysis, and quantitative knowledge. Participants were also given the Young Child Music Skills Assessment (MSA) test that measured specific musical skills. These tests were given by a music teacher and a professional musician not affiliated with the research project. For 9 months, children in the control group received no musical instruction. The children in the experimental group received musical training through Kindermusik for the Young Child Year 1 Pilot Program, a music and movement program geared towards young people from birth to the age of 7. For 30 weeks children received 75 min. of instruction once a week in three classes of approximately 12 children.

Caregivers were asked to participate in two of the weekly lessons and to come to the last 15 min. of all lessons. Participants were also given weekly homework that involved listening to a CD and playing the glockenspiel.

After 9 months, the SB and MSA tests were re-administered. Five of the original participants had moved or were absent so the results were based on the scores from sixty-six students. Parental involvement with and completion of out of class assignments in the Kindermusik program was variable. Findings showed that compliance with these two aspects of the program were directly linked to family income. Children of low income families rarely completed assignments and parental involvement was rare. Children of high income families completed three times the assignments of middle income families. Due to these discrepancies, researchers chose to test differences between the control groups at the three income levels as well as testing the combined group.

No significant differences were indicated in the pretests of the control group and the experimental group. The experimental group had significantly higher test scores on the MSA post test than the control group. Test scores were not the same for all income levels. Children of high income families received higher scores than the rest of the experimental group on all but one area of the MSA test. In the SB tests, there were no significant differences in the areas of vocabulary, memory for sentences, pattern analysis, or quantitative reasoning. Bead memory test results showed that children in the experimental group with middle to high household income had on average higher test scores than the control group. (one-way ANOVA: non-Head Start Exp: $F(1,43)=6.29$; $p<16$). Also, improvement on test score in the experimental group increased linearly along with compliance. Findings indicated that children in the experimental group were

twice as likely to have significant improvement in bead memory. Those with compliance one-half of the time were three times as likely to show improvement.

This study lent support to the idea that there is a link between music instruction and abstract reasoning, visual imagery, and sequencing strategies. It also indicated a link between higher test scores and higher parental involvement and higher income level. While the study is weakened due to a lack of control for maturation, the full year duration gives strength to the study. Because students from lower income families were less likely to complete homework assignments and have parental involvement, the researchers would be wise to initiate further studies of this sort in which parental involvement and homework are not options. In this way researchers could control for other variables that might be the sources of the difference in findings.

Brochard et al. (2004) used two correlational studies to inquire into the question of whether musical expertise effected visuospatial abilities on a long-term basis. The first experiment involved 10 musicians or musicology students with at least 8 years of music training, who practiced at least one musical instrument for at least 4 hours per week, and who could read music, and 10 non-musician psychology students who could not read or play music. The participants consisted of 6 males and 14 females of the mean age of 23.3 years.

This experiment involved participants who looked at a 640 x 480 pixel computer screen. After a warning beep, a reference line was flashed upon the screen for 500 milliseconds *(*ms). Next, a target dot was shown for 200 seconds (s). Subjects were tested for horizontal as well as vertical discrimination. In horizontal tests, subjects were asked to press on the keyboards left or right arrow to indicate what side of the reference

line the target dot was on. For the vertical test, subjects were asked to press on the up or down arrows to indicate whether the target dot was above or below the reference line. Subjects performed the experiments in a dark room with their heads 50cm away from the screen. They performed in two experimental conditions, one in which the reference line disappeared 1000ms before the target dot was shown, and the other in which the reference line stayed on the screen. Correct answers and reaction times were recorded.

For the variables of reaction time and percent of correctness, an ANOVA was performed. The ANOVA of correct answers illustrated that when the reference line stayed on the screen, discrimination became easier (96.8% correct). Participants found it harder to keep a mental representation of the line after it came off the screen (67.8% correct). Due to the number of correct answers, this indicated a similar level of difficulty for both groups in all circumstances. On average, in all experimental conditions, musicians reacted faster than non-musicians (musicians 380 ms, non-musicians 440 ms on average). All participants did better with horizontal axis detection than vertical detection (343 ms for right/left judgments vs. 477 ms for above/below judgments on average). Reaction times were longer (428ms) when the reference line disappeared than when it stayed on screen (392ms). Musicians' did most significantly better than non-musicians in vertical detection. Musician's higher performance in vertical dimension tests suggested that musicians have better abilities at mental imagery.

The second experiment involved 12 musicians that did not take part in the first experiment but were selected under the same criteria. Participants consisted of 10 males and 14 females with 12 non-musicians.

This experiment measured simple reaction time by flashing a small white circle in one of four different areas on a computer screen. Subjects pressed the space bar on the computer when they saw the circle. To measure choice reaction time, a green or red circle was flashed on a computer screen. Subjects were asked to press the left arrow when they saw the green dot and the right arrow when they saw the red. Results of this study showed that musicians were faster than non-musicians in both tasks ($p < 0.01$).

The researchers of this study stated that their findings suggested that music expertise is related to improved visuospatial perception and imagery, especially on the vertical dimension, as well as faster reaction to visual stimulus or attributes. They did not claim a strong relationship and they asserted that further research is necessary to confirm their findings. Because the control group did not take part in an activity comparable to music instruction, such as athletics, or drama, the results of this study are weakened. Also, this study included a very small group of participants. Further research with a greater number of participants will give greater credence to this type of study.

Hanson (2003) investigated the effects of sequenced literacy-based Kodaly music instruction on the spatial-temporal skills, spatial recognition skills, and non-spatial, verbal skills of kindergartners in a qualitative experimental study. Study participants consisted of 54 kindergartners in three classes in a rural elementary school with approximately 400 students. The participants received no previous music or computer training and the regular kindergarten class received no music training.

To begin this study, researchers randomly assigned participants to the experimental groups and control groups with a coin toss. The experimental group consisted of two kindergarten classes assigned to two experimental groups. Experimental

group one (n=18) recieved sequenced Kodaly literacy-based music instruction. Experimental group two (n=18) received beginning computer skills instruction. Experimental groups met for 30 minutes, two times a week, over a seven month period from Oct 2000 to April 2001, culminating in 31 weeks of instruction. The control group (n=18) received no music or computer classes.

The Kodaly literacy-based music instruction received by the experimental group one consisted of instruction in concepts of beat and voice, rhythm, and reading and writing notation. They also took part in singing, dancing, and rhythm instrument playing. Experimental group two took part in computer instruction which included beginning computer skills instruction as well as basic academic skills learned on software programs such as Jumpstart ABC and Reader Rabbit Learn to Read.

Researchers pre and post tested students using the Object Assembly Task, which measured spatial-temporal skills; the Visual Closure Test, from the Woodcock-Johnson Psycho-Educational Battery-Revised (1989), which measured spatial recognition; the Absurdities Test from the Stanford-Binet Intelligence Scale (1986), which did not measure spatial skills, and the Wechsler Preschool and Primary Scale of Intelligence Scale – Revised (1989).

An ANOVA performed on each of the separate tests for the pretest and the post test revealed no significant difference between either of the experimental groups or the control group in the scores for spatial-temporal awareness, spatial recognition, or non-spatial ability.

Results of this study revealed no positive relationship between Kodaly music instruction and spatial and verbal skills, but no negative relationship was found either.

Hanson (2003) stated that students' musical skills and comprehension as indicated by worksheets and performance surpassed expectations.

Graziano et al. (1999) investigated the effects of spatial temporal training using a math video game, along with piano keyboard training, on the ability of second grade students to learn challenging mathematical concepts. This study began with a one month pilot study to investigate the effectiveness of the Spatial-Temporal Math Video Game software, a program developed by the researchers to teach math and science using a spatial-temporal approach. The software program included animal characters plus racially mixed boy and girl characters. Twenty students in the second grade received 50 minute sessions using the video game two times per week for nine sessions. Twenty other students took part in a control group that received 50 minutes of English language training on the computer. A third group did not receive lessons. Pre and post tests given using parts of the WISC assessed the development of the student's spatial reasoning skills. Results determined that the Math Video Game group received scores 36% higher than the English group and 14% higher than the No lessons group. Researchers thus determined the ST Math Video game to be an effective medium to teach spatial temporal skills.

The main study included 136 participants, six to eight years of age attending five 2nd grade classes at an elementary school in Los Angeles with below average academic achievement. Sixty-seven participants were boys and 69 were girls, 76 came from Hispanic origin, 59 from African American origin, and one from Caucasian origin. None of the students had previous music or computer lessons.

During this study, 26 participants took part in the ST Math Video Game training and piano training, 29 participants took part in the ST Math Video Game training and English training, 63 participants took part in the ST Math Video Game training only and 28 participants received no training. Prior to training, students were tested on parts of the WISC pertaining to spatial reasoning. Students were also tested four months and six months after the pretest and they took a post test after the training was completed. Students who took part in Math Video Game training only were tested using the ST Math Video Game Evaluation Program. Participants received four months of training. The Video game group received training twice a week for sixty minutes and the piano and English groups received training three times a week for sixty minutes.

Piano keyboard training groups began lessons by listening to Mozart piano sonatas for ten minutes. They then went on to learn basic music and piano concepts including rhythmic values and clef signs as well as reading music and performing simple melodies with both hands. The English students utilized a computer software program focused on teaching spelling, punctuation, sentence structure, and reading.

Findings revealed that on the Math Video Game Evaluation Program the piano group received scores that were 15% ($p<0.05$) higher than scores received by the English group on 44 of the test questions, and 27% ($p<0.05$) better on a subset 16 questions that pertained to proportional math and fractions. The piano group and the English group both received scores that were more than 100% higher than the scores of the group that did not receive lessons. The results of the WISC-III showed that the scores for both the piano group and the English group improved by approximately 1.5 points from the pretest to the posttest. Because the WISC-III was not designed to measure improvement in spatial

tasks such as fractions and proportional math, researchers chose to view these test results as a "baseline measurement of spatial reasoning, rather than a measure of individual performance after training" (p. 149 -150). Interviews conducted with teachers revealed qualitative improvements in the attention and concentration of the piano group students.

Results show that specific ST training in the Math Video Game, along with keyboard instruction enhanced student's ability to learn math concepts, specifically fractions and proportional math. Graziano et al. (1999) suggested that these two activities together can be used as an effective tool in the classroom and that large, long term studies should be implemented to further study the effects. The results of this study are strong due in part to an experimental design that included a control for the Hawthorne effect. Because these students were below average achievers, this study has positive implications for that population.

Vaughn (2000) performed a meta-analysis in which she investigated the relationship between mathematical abilities and music listening and music instruction. Vaughn performed three different meta-analyses on a total of 25 studies. She organized the studies into three categories which included correlational, experimental-music, and experimental music-listening, and performed a meta-analysis of each group.

The results of the correlational meta-analysis revealed a significant association between high scores on the mathematics portion of standardized tests and involvement in musical activities. The results of the experimental-music instruction meta-analysis found a small causal relationship between music participation and improved scores in mathematics. The results of her experimental-music listening analysis found a slight relationship between listening to music and increased mathematics scores.

Overall, this meta-analysis presented a well-rounded examination of the relationship between music and mathematical scores and offered a modest positive relationship.

Hetland (2000) conducted a quantitative meta-analysis of experimental research studies in order to determine the effect of music instruction on the spatial reasoning skills of preschool and elementary school students. Hetland chose fifteen studies that met specific criteria: 1) studies were recorded in the English language, 2) participants took part in instrumental or vocal music instruction, 3) included at least one control group in the study, 4) the study results included information on mental rotation or spatial visualization, and 5) statistics provided were numerous enough to calculate an effect size. The studies analyzed lasted from four weeks up to three years. Sample sizes ranged from 12 to 219 subjects, ages three to 12 years. Treatments given ranged from ten minutes to sixty minutes.

Hetland performed three separate meta-analyses on these studies and synthesized the results. The first and main analysis included all 15 studies with a total of 701 subjects, and investigated the relationship between music instruction and the spatial-temporal tasks of three to 12 year olds. The Object Assembly subtests of the Wechsler, Preschool and Primary Scale of Intelligence –Revised (WPPSI-R) was the most common test used in these studies. Hetland performed a contrast analysis to examine variables that could affect study outcomes. These variables included age and social/economic factors as well as program variables such as duration of lessons, lesson format, parental involvement, type of instrument used, notation, incorporation of movement, and composing or improvisation. Hetland also tested for research design features such as randomization, maturation, and the Hawthorne effect.

The next two meta-analyses were smaller and the results were compared to the main study. Meta-analysis number two used Raven's Standard Progressive Matrices to determine the relationship between music making and the general intelligence of participants. This analysis included three studies with 694 subjects. Meta-analysis number three examined studies that used spatial tests other than spatial-temporal reasoning measures. These included tests of spatial recognition, spatial memory, and spatial visualization. Eight studies with a total of 655 participants were included in this analysis.

For the first meta-analysis, effect size across the fifteen studies was consistent. For mean effect size, r = .37, for weighted sample size, r = .39. Hetland conducted Stouffer's Z significance tests that indicated the unlikelihood that results were effected by error or chance (Stouffer's Z = 8.74, $p<.0001$ and t of the mean Zr = 7.50, $p<.0001$). Results of the contrast analysis found that studies which included notation instruction had higher results than studies that did not include notation. Also spatial-temporal reasoning skills improved more with group lessons than with individual lessons. No other significant differences were indicated.

For the second meta-analysis, no significant relationship was found between music making and general intelligence scores (r = .08, weighted r = .03; Stouffer's Z = 1.32, p = .09; t of the mean Zr =1.23, p = .29). For meta-analysis number three, results indicated a small relationship between spatial skills and music training (r = .26, weighted r =.20; Stouffers Z =5.27, $p < .0001$; t of the mean Zr = 6.11, p = .0003).

The results of this meta-analysis led Hetland (2000) to assert that music instruction leads to improvement in spatial-temporal reasoning. This study offered moderate

evidence that a relationship does exist between involvement in music making and increased spatial-temporal skills in preschool and elementary school-aged children.

This section examined relationships between music instruction and mathematics and spatial reasoning skills. In the first study of this section Rauscher et al. (1997) found that individual keyboard and group singing lessons positively impacted long term spatial-temporal skills. Rauscher & Zupan (2000) continued this work in an investigation that determined a positive relationship between group keyboard lessons and general music training, and spatial-temporal skills. Bilhartz et al. (1999) found a significant link between early childhood music training, socioeconomic status, and spatial skills. Brochard et al. (2004) found small correlations between music participation and visuo-spatial skills. Hanson (2003) found no significant relationships between Kodaly music instruction and spatial skills. In a well designed study, Graziano et al. (1999) determined that keyboard instruction integrated with a spatial-temporal focused math video game increased low-achieving student's scores in fractions and proportional math. Vaughn (2000) investigated the relationship between music and mathematics. She found a modest relationship in correlational studies, a small relationship in experimental studies, and a slight relationship in studies involving the use of background music. Hetland (2000) performed another meta-analysis that found a consistent positive relationship between music participation and spatial skills. These studies represent a growing body of research that is finding positive relationships between music and mathematics and spatial skills.

Background Music

Many researchers contemplated the relationship between background music and an enhanced classroom environment. The four research studies featured in this section look into this question from different angles. Lewis (2002) examined how academic performance and reading skills are affected when first graders listen to background music. Hallam & Price (1998) explored the relationship between listening to background music and mathematical achievement and behavior. Anderson, Henke, McLaughlin, Ripp, & Tuffs (2000) investigated the relationship between classical background music and spelling word retention. Carlson, Gray, & Hoffman (2004) examined the effects of the integration of classical music and relaxation on reading skills of third graders.

In a quasi-experimental study, Lewis (2002) investigated the effect of background music on first graders' memory retention and academic performance. Selected by the principal of a school in Eastern Tennessee, participants included 39 students, 21 females, and 18 males in the first grade. Seven students received English as a second language services and one student took part in American Sign Language at home. Participants came from a variety of ethnic backgrounds.

The study took place during two 3 week time periods for forty minutes a day between January and March. The initial three weeks of the study took place without background music. Students took part in C.A.R.E., a specific reading curriculum developed to facilitate student's ability to learn to read and identify sounds; along with Scott-Foresman reading curriculum, the reading curriculum utilized by first graders at the school. For the second three week time period, students took part in the same curriculum with classical

music playing in the background. The music played were pieces by the classical composer Tchaikovsky.

After each three week interval, students were tested on the C.A.R.E curriculum as well as the Scott- Forsman reading curriculum with the same test.

A paired sample t-test was used to compare both of the tests from the two different intervals. Analysis of test results revealed that while students scored significantly higher on the C.A.R.E. test after the music treatment (mean score with no-music = 117.2821, mean score with music = 119.2308), their scores were significantly lower on the Scott-Foresman test after the music treatment (mean score without music = 9.2308, mean score with music = 8.8205). Although small, the differences for both tests were significant at the .05 level. Lewis (2002) stated that the lower scores on the Scott-Foresman test may have been due to the music being too loud while the teacher was speaking.

This study does not lend strong support to the argument that background music may facilitate learning. The lack of control group made it impossible to determine whether advances in reading and sound identification could be attributed to listening to music. The absence of controls for the Hawthorne effect and maturation further weakened this study. The students studied the materials before the inclusion of music and they took the same test twice, once after study without music and then again after study with music. They may have performed better the second time because they were familiar with the material.

The researchers concluded by stating that music played during the C.A.R.E. lessons did not inhibit the learning process. They recommended that further research be done in

the area of using music in the classroom and that teachers may want to use music in the classroom to enhance their learning environment.

Hallam & Price (1998) conducted a quasi-experimental study to determine the effect of background music on the mathematics achievement and behavior of students with emotional challenges. This study included ten participants, eight girls and two boys between the ages of 9 and 10, who were pupils at a school for students with behavioral and/or emotional challenges. Prior to the study, the children demonstrated frequent disruptive behaviors such as physical and verbal aggression, tantrums, crying, general over-activity, and destructiveness. All of the students had normal IQ's, with no diagnosis of brain injury.

During this study, students completed math problems in trials without music and with music. Initially four trials were given without music and four trials with music. After a period of one week these trials were repeated in the reverse order, with three trials under each condition. Music that was previously identified by students at the school as calming was played during the music trials.

During each trial students were given a packet of arithmetic problems. They were instructed to quietly sit and correctly complete as many math problems as possible within the given time. They were allowed to raise their hands and ask for help if needed. If the behavior of a student was such that it would disrupt the progress of other students, that student was asked to leave the room and their scores for the session were omitted. During each session the number of times rules were broken, and the number of correctly completed problems was recorded. Students were not told the nature of the study or the reasons why music was playing.

Study findings showed the mean mathematics scores with background music to be 38.5 (SD15.1) and scores with no background music to be 21.5 (SD 8.91). A repeated measures t-test found the differences to be significant at the .002 level (t= -4, 7,df =8). In regards to rule breaking, the mean score was 17.3 (SD 6.07) when background music was present and 21.3 (SD 6.09) when no background music was present. The difference was not statistically significant (t = 1.9, df =8, p = .09). After analyzing the data, researchers determined that during the first trial, students were adjusting to the background music, causing a lack of significant difference. The researchers, therefore; removed this trial from the analysis and carried out a paired t-test. This test revealed a significant difference between the two trial conditions at the .001 level (t = 4.89, df = 8), with rule-breaking behavior while background music was being played being significantly decreased. Correlations that were conducted between the number of rule breaking incidents and the number of completed math problems exposed significant negative association (r = -47, p =.036). This indicated that the improved math scores were, in part, related to improvement in classroom behavior, which was in turn related to the influence of background music. Hallam & Price stated that "in four out of the seven sessions there was a significant positive effect on mathematics performance when background music was used. Even where the differences were non-significant, the effects of the music were always positive" (p.90). No negative effects were found on either behavior or performance while background music playing.

According to Hallam and Price, their study findings indicated that children with emotional and behavioral difficulties may be positively impacted by the presence of background music in regards to performance in mathematics and behavior. The use of a

control group as well as controls for the Hawthorne effect and for maturation could improve the usefulness of this study. Without these controls, the researchers were not able to determine whether the improvement in behavior was due to the use of background music or other factors. The very small sample size makes it hard to generalize this study to other populations.

This study presents limited evidence of a relationship between music, improved behavior, and improved mathematics achievement. It paved the way for further experimental research investigating these associations.

In a qualitative study Anderson et al. (2000) explored whether background music used in the classroom could effectively enhance spelling word retention and result in higher test scores. Fifty - nine students attending three elementary schools in middle class communities in a suburb in southwestern Chicago participated in this study. Participants included students in a first grade regular education class, a fourth grade gifted class, another fourth grade class with cross-categorical special education students, a third grade class with cross-categorical special education students, and resources students attending a fourth grade class. At school A, 54.9% of the students were Hispanic, 45% Caucasian, 13.7% African American, and 0.9% Asian American or Pacific Islander. At school B, 92.7% of the students were White non-Hispanic, 3.0% Asian or Pacific Islander, 1.6% Black non-Hispanic, and 0.4% Native American. At school C, 90% of the students were Caucasian, 9% Hispanic, and 1% Asian or Pacific Islander.

This study took place from January 1999 to June 1999. Prior to the treatment component of this study, documentation was gathered concerning the spelling retention of the participants. This documentation included observational checklists, anecdotal records,

informal assessments, student report card grades and spelling test grades. Analysis of this documentation revealed low scores in spelling word retention assessments. Students were observed for off-task behavior such as talking, pencil tapping, inattentiveness, and movement in and out of seats during the period of time that spelling instruction was taking place. Participants were given a pre-intervention survey about their feelings about music. Students were also given a pre-intervention review test at the end of the semester, to gauge their ability to correctly remember the spelling of words learned during the semester.

During the treatment period, 45 minutes a day were spent on the spelling content area. Students learned new spelling words at the beginning of each week and throughout the week took part in a variety of spelling activities in order to learn and retain these words. At the end of each week, students were tested to gauge ability to correctly retain spelling words. During all of these activities, selections of classical music were played from The Mozart Effect Music for Children (Vol.1) Tune Up Your Mind. The behavior of students was observed and documented during this time period. Teacher observations, anecdotal records, as well as student surveys were also collected in order to document the effects of the intervention.

Researchers collected and compared and contrasted all pre and post treatment findings. Analysis of the pre-treatment findings revealed that on the pre-intervention review test, 51% of the students scored a C or below and 17% of the students scores a D or below. Pre-treatment spelling grades showed that 24 students received an A, 19 received a B, 16 received a C or below. Analysis of the post-treatment findings revealed that students received significantly higher test scores on the post-intervention test than on

the pre-intervention test. After the intervention, 77% of the students received an A or B on the test and 23% of the students received a C or below. A comparison of pre-treatment with post-treatment report cards revealed a 13% increase in students receiving an A and a 7 % increase in students receiving a B. Also the number of students who received a C fell by 4% and the number of students who received a D fell by 3%. Anecdotal records documented before and during intervention revealed positive changes in student's behavior during the intervention. These behaviors included staying on task for longer time periods, greater concentration, fewer requests for words to be repeated, and greater enthusiasm for spelling activities. In the post survey, 81% of the students responded that music made them fell relaxed, in relation to 66% of the students that agreed with this statement prior to the intervention. This may indicate that students recognized the relaxing effect of music as a result of the intervention.

Students in this study experienced an increase in test scores as well as in report card grades after the introduction of background music. They also exhibited fewer off-task behaviors. The incorporation of regular education, gifted, and special education students in this study strengthened the ability to generalize the results to wider populations; however, the participants came from mainly middle class backgrounds and possibly experienced previous exposure to classical music. While this study offered some support to the use of background music in the classroom, the study's limitations, including no control group and no controls for maturation and the Hawthorne effect weakened its validity. More research is needed that incorporates participants from different income brackets in order to generalize these findings.

Carlson et al. (2004) examined the effects of music and relaxation on the performance of reading, in a quasi-experimental quantitative study with thirteen third graders from an elementary school in the urban Midwest. Participants included eight girls and five boys, nine Caucasian, two African American, and two Latino. All of the participants of this study were in general education classes with two students in special reading class, one in English as a second oral language (ESOL) class and 10 at risk students.

During this study, participants sat in a donated vibroacoustic music chair, a bean-bag like chair with speakers inside of it, while performing reading and writing-based tasks. Participants sitting in the chair could feel the vibrations of the music while sitting in the chair. The chair played music from two CD's, Musical Acupuncture, and Musical Massage, both by Hoffman and both with a tempo of 50 to 60 beats per minute. Students sat in the chair while reading alone, reading with a partner, creative-writing, taking exams in any subject, and while working on academic assignments. All students sat in the chair for approximately 20 minutes 3 times a week for 23 weeks. Chair use lasted approximately six months.

Students took pre and post tests using The Reading Inventory for the Classroom, which measured reading accuracy and comprehension, and the San Diego Quick Assessment Test, which measured sight-word recognition. Test scores for special reading and ESOL students were dropped from the study because they were given specialized reading instruction which may have impacted findings. Two students that did not have pre and post test scores were dropped from the study.

During comparison analysis, The Wilcox Signed-Ranks Test found significant positive difference between the pre and post tests in sight-word recognition ($p = .016$) and

reading comprehension (p=.042). According to Carlson (2004), most students "showed gains up to two years in word recognition and three years in comprehension" (p. 248). Accuracy in oral reading did not show statistically significant improvement. However, the author stated that an increase of one to two years in individual scores took place for 88% of the students.

In this study Carlson et al. demonstrated the potential relationship between sitting in a vibroacoustic chair and improved reading skills. The inclusion of pre and post tests strengthened the relationship between the treatment and improved reading skills. Limitations to this study include a small sample size, lack of a control group, and lack of controls for maturation and the Hawthorne effect. Because no correlations were made, it cannot be determined whether the positive test scores were a result of the music or the physical movement of the chair, or other confounding factors. Also, some schools may not be able to afford a vibroacoustic chair. Further research into the mixed effects of music along with relaxing physical effect could substantiate the relationship between the combination of music and relaxation, and reading improvement.

Overall these studies indicate the potential for only a small association between background music and improved academic achievement. These studies cannot be generalized to other populations due to small sample sizes and lack of controls for confounding factors such as maturation and the Hawthorne effect. Most of these studies used classical music as background music, with the exception of Hallam & Price (1998) who used unidentified calming music. These studies indicated a need for research studies that examine the use of different types of music. More experimental research with

treatment groups to control for potential variables are needed in order to fully determine the relationship between background music and student achievement.

Using Music to Create a Meaningful and Productive School Environment

Music exists in all cultures, it is used as a way to express and communicate information and emotions (Curtis, 2007). Music is an integral and everyday part of children's lives, children naturally sing, hum, create rhythm, communicate, and socialize through music (Lum, Shehan, & Cambell, 2007). Music is an important part of some adolescent's lives; it assists them with identity formation, emotional expression, character building, socializing, and tolerance of age and cultural differences (Shehan, Connell, & Beegle, 2007). Because music is such an important and integral part of student's lives and because students learn through connecting prior knowledge and meaningful experiences, music can be used as an effective tool in the classroom to facilitate learning and promote positive self-esteem.

Educational philosophers such as John Dewey and Jean Piaget asserted that learning occurs when students can build on prior knowledge, and when the content presented to them is meaningful. Piaget asserted that children learn through actively interacting with their environment and through play. Lev Vygotsky explained that children learn through social interactions (Curtis, 2007). Jensen (2005) described healthy learning for the brain as being engaging, active, and relating to real life experiences. Teachers must find developmentally appropriate ways to facilitate effective learning and to create a classroom atmosphere supportive of learning. Allowing musical expression in the classroom during the school day creates a healthy environment in-tune with student's natural tendencies.

The following studies explored how music can be used in the classroom to facilitate the learning experience. Shehan et al. (2007) investigated the importance that high school

students attributed to music in school. Shields (2001) investigated the effect of music education and mentorship on the lives of at-risk youth. Lum et al. (2007) investigated the natural musical soundings in an elementary school environment. McGovern (2000) examined how music was used in an elementary school classroom as a teacher tool and as a management tool.

In a qualitative study, Shehan et al. (2007) studied the significance of music and music education to middle and high school adolescents by examining responses to a national essay contest entitled “Ban the Elimination of Music Education in Schools”. One thousand, one hundred, and fifty-five American middle and high school students, 13 to 18 years of age responded with essays and statements. Two-thirds of the respondents were 14 to 16 years old and seventy-eight percent were girls. The essay contest was run by themusicedge.com and Teen People Magazine. The contests asked participants to submit online essays justifying music’s continuing status as a school subject. The winning essayist’s school won a visit from the violinist Sean Mackin who played with a popular punk-rock band Yellowcard.

A content analysis of the submitted essays was conducted by a research team made up of three individuals with 50 combined years of experience in music education at primary, secondary, and tertiary levels. Categories were quantitatively determined using inductive reasoning. The NVivo software program was used to code and manage the information as well as search for common words and phrases. Researchers identified commonly used terms and meaningful themes that emerged from the essays. They identified five principle themes: A) identity formation, B) emotional benefits, C) music’s benefits to life, D) social benefits, and E) music’s use in schools.

In an analysis of the results more than one-third of the respondents identified themselves as either currently taking part in or had at one time taken part in music instruction through instrumental, vocal, ensemble or the study of music theory or history. Students expressed that the knowledge and skill needed to play music benefited them. One 15 year old girl wrote, "Being a musician is a beautiful thing. Counting and knowing the names of different notes on a staff has helped me so much when it comes to [not only] reading music [but] even math class" (p. 222). The essays of some students indicated that they appreciated the cultural and historical importance of music. One 14 year old girl wrote, "History class just isn't enough. You'll find the culture and way of life of people and different countries through the music" (p.223). A 16 year old girl wrote in defense of music's role in school, "Music is part of American culture. If you look at history, music has been used in every generation. How could anyone take away something that has been part of this country for so long" (p.223)? Two of every three respondents stated that music had emotional value and meaning. Students indicated that music gave them freedom to be themselves. Students stated that music had the therapeutic benefits of helping them to control their emotions and cope with life's pressures. A 15 year old girl stated that "the only way for most teenagers to express their anger…in a nonviolent way is through music" (p. 223). Respondents expressed that music cultivated skills such as self discipline, responsibility, patience, concentration and memorization that helped them in other academic areas. They responded that music involvement gave them a sense of belonging. A 13 year old student responded "Music gives you a place to belong inside and outside the walls of your school" (p. 223). Students involved in band, choir, or orchestra described feeling part of a family. The authors stated that "There was

acknowledgement that music diminishes boundaries between people of different ethnic backgrounds, of different age groups, and of different social interests" (p.223). Students responded that music gave purpose to life and discouraged destructive behaviors such as drug use, drinking alcohol, smoking, gang life, promiscuous sex, and also helped with depression and suicidal behaviors. An eight grade student wrote

"When I was only ten years old, people were trying to get me to do drugs, and I won't lie, I did try it. And I started getting involved more and more with different kinds of drugs. Then when I was twelve, I got involved with playing the clarinet. I loved it! I didn't mind that it wasn't the instrument that I wanted to play, but it kept me away from drugs, and other bad things. And now I'm thirteen and I love music! It plays a big part in my life. Anything that has to do with music, I'm involved in. Even if it's just helping out in the music room. It still helps" (p.223).

Many students stated that they valued music as a school subject and claimed its importance. While minimal negative comments about music in school were expressed, some students revealed the desire that schools incorporate other kinds of instrumental studies such as guitar, bass, and composition, other than just classical instrument study.

The author's stated that, "The nature of the research brought forth from adolescents their justification of music's benefits to them personally as well as its continuing status as a subject for study in school."

The qualitative results of this study provide evidence that many students find music participation in school extremely beneficial and that it benefits many parts of their life. Because the data is limited to those who responded to the on-line essay and no information is known about social, economic, or ethnic backgrounds, results of this study

cannot be generalized to other populations. However, the study gives a view into the importance that high school students attach to the music in their lives.

Shields (2001) examined whether music education could be used as intervention in the lives of at-risk urban adolescents. Participants in this study were sixth grade students at an alternative school for the arts situated in a large and urban school district in Midwest America. Forty-two percent of the participants were girls, 58% boys, 58% African American, and 44% White.

The participants were identified as potentially at-risk students by homeroom teachers, the guidance counselor, or the principal and through information obtained by an at-risk referral form. These participants self-selected to take an extra, optional music performance class, beyond the one music class required for all students. During the study period, ten of the students took part in creative percussion, 28 took part in choir, and two took part in both classes. All participants had various opportunities to perform. Music teachers acted as mentors. They took note on and addressed students needs and problems musical and non-musical. The teachers provided extra music support and/or listened to personal troubles. They communicated student needs with other school personnel and conducted home visits.

Students took pretests and a posttest from two tests. The "Self-Perception Profile for Children" test included the "Importance Rating Scale" which measured the level of importance that students attached to different areas of their lives. The "Social Support Scale for Children" test measured sense of social regard and support felt by students. Student and parent opinions were gathered through interview questions that addressed the student, their school experience, the role and importance of music in student lives,

student's participation in music performance groups in school, the role of music teacher as a mentor, and issues around participation in ensembles. Interviews were analyzed for emerging themes.

Statistical comparisons of pre and post tests revealed the following findings. The "Self Perception for Children" test measured scholastic competence, social acceptance, music competence, physical appearance, behavioral conduct, and global self-worth. The only area with significant change was in music competence (pretest- $M = 3.12$, $SD = .64$, posttest – $M = 3.30$, $SD = .57$) score ($t(33) = -2.291$, $p<.03$). Moderate positive correlation between self-perceptions of musical competence and global self-worth were found on the pretest $r = .38$ ($n = 34$) and the posttest found low positive correlation $r = .17$ ($n = 34$). Seventy-six percent of the students ranked music as important on the pretest and 82% did on the posttest. No significant difference was found in regards to all four domains of teacher, parent, classmate, and close friend social support. In interviews students indicated that participation in the music classes brought them pleasure, happiness, pride, and social benefits. Parents indicated that the classes were a positive experience. Shields noted that problems occurred in music classes due to large numbers of at-risk students who sometimes caused chaos and negativity in the classroom.

The results of the pretest and post-test analysis indicated that music class did not effect student perceptions other than musical. The interviews suggested that students felt happiness and pride through involvement in musical activities. The results of this study suggested that music teachers may not be equipped to act as mentors to at risk students but that music involvement does bring positive effects to students' lives. Further research with at-risk populations in rural and suburban settings, for longer periods, and in

controlled settings where results could be generalized to other populations would be beneficial towards understanding the effects of music participation.

In an ethnographic qualitative study, Lum et al. (2007) inquired into the sonic surrounds of an elementary school community. This study investigated the natural musical soundings made by elementary school students, 1st through 3rd grade at a west coast school in an urban residential neighborhood. The school which was within close proximity of a major city road as well as restaurants and shops, features architecture from the 1920's and had recently been newly renovated and given state-of-the-art technology. The school adopted a new curricular focus in a culturally diverse community in which communication, international languages, and technology were featured. The ethnic makeup of the school was 41% White, 30% Latino, 21% Asian or Pacific Islander, 7% African American, and 1% Native American.

Over a six month period students were observed on a separate schedule, by two observers. Both observers were experienced music educators who also had experience in an elementary school setting supervising music teachers as well as student teachers. The observers watched students in a variety of school locations, in formal as well as informal settings, at different times during the day from one hour to a full morning or afternoon, for one or more days a week, at different days a week, inside and outside, in classrooms, hallways, and on the playground. The observers tried to be non-disruptive and inconspicuous. They observed, took field notes, and sometimes audio recorded students as they were playing and working. Observers put in 72 hours of observation time which averaged 3 hours per week. They wrote 64 pages of field notes which were organized, examined, and written into an expanded form after observations and then categorized.

When they returned to the school, observers went through a member-checking process in which they would interact with students in an attempt to monitor outsider perceptions.

Observers found that students at the school were involved in many types of musical behavior. They engaged in rhythmic play, a music and movement activity which often incorporated speech-inflected chanting. This rhythmic play which, manifested itself in a variety of ways in the classroom during free play time and work time and at recess, seemed to be happening almost continuously throughout the school day. Students chanted numbers and or words in unison or alone during recess and tapped pencils rhythmically in the classroom. Melodic musical utterances that involved the singing of sustained notes encompassing from a few to many notes, were also a common occurrence. Children made these utterances alone and in groups, they sometimes had words and other times only sounds. These utterances were used by children to increase the excitement of play. At one point a boy who had been excluded from his classmates sang to himself, maybe to help himself feel better. Melodic utterances were sometimes made up and sometimes segments of familiar songs. Many had cultural implications based on students' personal experiences.

Another common occurrence at the school was the creation and re-creations of familiar songs. Students sang whole songs such as "London Bridge", "I've Been Working on the Railroad", and "We Will Rock You" by Queen. One girl from Somalia who could not speak English surprised one of the researchers when she tapped him on the shoulder and sang "We Wish You a Merry Christmas", indicating to him that she was communicating through song. Recreations of familiar songs were sung in which children would make up funny and/or relevant words to familiar songs.

Teachers at the school used music as social signaling. They would use clapping call-and-response methods to obtain students attention or direct them to a new activity. One teacher used a singing game from Ghana to engage students and lead them into a line for their next activity while avoiding distractions.

Teachers integrated music into the classroom to facilitate lessons. Teachers tapped a beat with a pencil or a drum while students chanted words they were learning. In the Japanese language classroom students spent 5 to 10 minutes singing. They sung "Twinkle-Twinkle Little Star" in Japanese. In math class, the teacher used rhythmic movement to illustrate mathematical concepts. Students responded in an enthusiastic manner to these techniques.

This study revealed music to be an authentic aspect of students' lives. Music had a natural place on the playground and in the classroom as a social activity as well as an individual activity. Teachers used music to support student learning processes and engage real-life experiences. This study made no assumptions about the need for music in the classroom; it only suggests that music is an important and integral aspect of children's lives. The case that this study seeks to make could be stronger if more than one school was studied. The particular school studied valued diversity and communication. There is no indication why this school was chosen or what the economic demographics of this school were. Further studies done at a variety of schools with populations from diverse economic backgrounds could give further support to claims.

In a study involving third graders in a suburban K – 6 elementary school classroom, McGovern (2000) explored how music enhanced the environment and climate of an elementary school in regards to student behavior, attitude, and classroom management.

The demographics of the participants of the study were 91.4 % African American, 6.9% White, and 1.7% Hispanic. Low income students made up 61.5% of the participants and large percentages were categorized as at risk. Out of 18 student participants, 11 were girls and seven were boys.

According to the Illinois Goal Assessment Program scores, the participating school's scores (213) were lower than the state average (246). Thirty-five percent of the school's third graders did not meet state reading goals while 28% of the students in the state did not meet these goals. For Writing 49% of this school's students did not meet state goals while statewide, 13% did not.

The study was conducted during the first 18 weeks of the 1999-2000 school year and began with students filling out a survey about their feelings about music. Parents were also asked informally about their opinions about music within the classroom. The study encompassed three categories of study. The first category, climate and management, began with playing classical Baroque music at a low volume in the background during teacher instruction and student work. The music could only be heard if the classroom was completely silent. Baroque music was used because its tempo is equal to that of the heart in a relaxed state, 60-80 beats per minute. The teacher used a checklist to note whether the music had a relaxing effect on students prior to lunch or recess. The teacher also used this checklist to note whether up-tempo music was effective to enliven tired students. During another week, the teacher used rhythm as a classroom management technique. The teacher performed a rhythm as a way to obtain students' attention. The students would join the teacher in this rhythm when they noticed the teacher doing it. On another week the teacher would play an instrument during cooperative work time. She would tell

students that they needed to be able to hear the music while they worked together. When the teacher wanted students' attention, she would play very loudly and then very softly, down to no volume.

The second and smallest category of this study involved student motivation. Uplifting songs about the positive aspects of children were played as students entered the classroom. These songs were from "Chicken Soup for the Soul."

The third category was concerned with learning and skills. Rhythm spelling, in which rhythms were used to assist in spelling of words, was used as a teaching strategy. For example, during an English-based lesson, students were taught to clap on consonants and stomp on vowels. They were allowed to utilize this strategy by quietly performing learned rhythms during a spelling bee and a spelling test. Other strategies used by the teacher were songs to help students remember vowel sounds, and songs to teach students how to regroup in addition and subtraction.

After each category was presented, it was used again by the teacher as needed. The last weeks of the study were dedicated to implementing a variety of the above strategies in the classroom. At the end of the study, students were given a survey asking what they liked and did not like about the strategies employed.

Pre-study surveys indicated that Rap was the favorite music of students. The survey also found that 7 of the seventeen students did not like to listen to classical music. While all of the students indicated that they liked music in general, nine students indicated that they did not think that music could help them learn.

The post-study survey demonstrated that all students liked something about the use of music in the classroom. While many students indicated that using music in the classroom

was helpful, there were also aspects that many students did not like and did not think were helpful. All students said they liked something about the clapping rhythm. 15 of eighteen had something they didn't like about the clapping. Seventeen of 18 thought the clapping worked and 12 of 18 wanted to continue using the clapping technique. The song Macarena was played to help lessen the chaotic atmosphere when students cleaned out their desks; when they were done, they could do the dance that goes with the song. 15 of 18 students said they liked this, 10 said there was nothing they did not like, while six said there were things they did not like. Some comments that students indicated as negative were positive for the teacher such as, "It helps us clean our desks better." 14 students said the song helped them to clean their desks better. 13 students thought they should continue using the song. In the "Rhythm Spelling" survey, 15 of 16 respondents said they liked it. One student said, "If I forget how to spell the word, I can think of the rhythm." 13 said there was something they didn't like about "Rhythm Spelling." 15 students said the activity helped them with spelling. 14 said they would like the strategy to continue. 12 of 17 students said there was something they liked about the positive morning music. 5 said they didn't like it at all. One student said, "I feel like it's too early. Please turn it off." Nine students said the music made them feel good about themselves, 6 said it did not. 9 students said the music should be continued, 8 said it should not. Some students commented that they did not like the music because it was too quiet. 17 students liked something about the classical music. 11 out of 18 students said the music did not help them concentrate on school work. Nine felt that the music should continue and 9 felt it should stop. Referring to motivational music, 16 of 17 had reasons to like it. 11 out of 17 had reasons to not like it. When asked whether the music helped them to wake up, 16 of

17 said yes. All 17 students said they would like to continue using the music.

The results of this study signified that students had varying responses to the use of music in the classroom. In general students seemed to mostly enjoy the clapping rhythm, the clean-up song, rhythm spelling, and motivating music. The majority of the students indicated that music played during instructional time did not help them to concentrate on their work. This study indicated that using music in the classroom as a tool for management, motivation, and skill learning, may be a positive strategy for teachers to utilize. Teachers must, however, be aware of the specific likes and dislikes of their students and tailor their approaches to meet individual needs. The strengths of this study come from the fact that students themselves were surveyed about what they liked and disliked in regards to classroom approaches using music. While this provided useful and pertinent information, the lack of control group as well as pre and post testing done in this study made it impossible to gage whether using music in the classroom resulted in increased student learning.

The studies in this section illustrated that music is an important and integral aspect of children's lives in the classroom. Shehan et al. (2007) determined the importance of musical opportunities in the lives of high school students. Shields (2001) found no non-musical benefits for at-risk youth as a result of music training and mentorship by the music teacher. Lum et al. (2007) determined that music is integral to a school community. McGovern (2000) determined that music was effectively used in the elementary school classroom as an educational and behavior management tool.

Summary

This chapter of this paper examined the research base that exists concerning the relationship between musical activities and enhanced intellectual and academic skills, and a meaningful and productive classroom environment. The section was separated into five sections: Memory and Standardized Tests, Literacy, Mathematics and Science, Background Music, and Music in the Classroom. Together these studies revealed that active participation in musical activities does enhance intellectual development and academic achievement, and promotes a productive and meaningful classroom environment. These studies found a very weak relationship between listening to background music and these attributes.

CHAPTER FOUR: CONCLUSION

Introduction

Chapter one of this paper introduced the context surrounding the research base investigating how music participation effected cognitive development, academic achievement, and school environment. Chapter two provided a historical background for this research. The literature in chapter three revealed that, while small, a positive relationship does indeed exist between participation in musical activities, academic success, and a productive school environment. This chapter will give a summary of the findings of the research articles in chapter three. This chapter will then present implications for the classroom that are indicated by the research articles and offer suggestions for further research in the area of music and the classroom.

Summary of Findings

Chapter three began with a group of studies that examined the relationship between participation in musical activities and memory and standardized test results. Chan et al. (1998) established a preliminary positive relationship between music participation and verbal memory. Lee et al. (2007) found a relationship between music participation and working memory, specifically phonological storage. Schellenberg (2004) found modest associations between keyboard and voice training, and enhanced cognitive skills, although these cannot be generalized to other populations. Schellenberg (2006) revealed a small yet long term relationship between the duration of music lessons and cognitive effects. Cox & Stephens (2006) found only a slight trend between the number of music credits received and grade point averages. Johnson & Memmott (2006) investigated the relationship between standardized test scores and the quality of a school's music program

and found no significant relationship. The weak design of the latter two studies further limits their implications. In a study of low-income students, Costa-Giomi (2004) examined whether piano instruction influenced academic achievement and self-esteem of low-income populations and found positive results only for self esteem. Fitzpatrick (2006) conducted a study of the relationship between standardized test scores, instrument training, and socio-economic status. His analysis determined that future music students received higher test scores before music instruction began, and that scores of low-income students increased throughout music instruction. Wallick (1998) found a positive relationship between strings instruction and standardized test scores. These studies taken together indicated a small relationship between participation in musical activities and increased memory and cognitive skills as assessed by standardized tests. These findings have positive implications for low-income populations.

A number of studies researched the relationship between music and literacy. Butzlaff (2000) conducted a meta-analysis of 30 research studies that examined whether a relationship existed between reading performance and music training. The meta-analysis included twenty-four correlational studies and six experimental studies. Because correlational studies made up the largest body of studies in this analysis, a causal relationship between music and reading was not established from them. The experimental studies establish a weak causal relationship. Overall analysis found a modest relationship between improved reading performance and music instruction.

Gromko (2005) investigated the effect of music instruction on the phonemic awareness of kindergarten children. Students who received music instruction received significantly higher scores than students who did not, especially in the area of phoneme –

segmentation fluency, from pre to post test. This study offered strong evidence of a relationship between music and phonemic awareness. A stronger design would strengthen the study results.

Register (2001) researched whether music therapy curriculum had an effect on the prereading and writing skills of four to five year old students. The majority of the participants in this study consisted of English language learners with a significant number receiving speech support. The treatment group received music therapy lessons designed to teach pre-reading and writing skills. Analysis of results determined that the treatment group experienced significant improvement in Logo Identification and Word Recognition. This study presents positive implications for English language learners as well as for the integration of music and reading and writing activities.

In another study Register et al. (2007) examined whether the integration of music and reading would result in increased reading comprehension and vocabulary skills. The participants of her study consisted of second grade students and students with reading disabilities. While study results indicated positive results for the students with reading disabilities, the small sample size and lack of control group for that population reduces the usefulness of the results. A modest positive relationship was found for the second grade students, specifically in the area of word decoding.

Curtis (2007) observed how music can be integrated with literacy study in the regular classroom and in the music classroom. She determined that music and literacy could be successfully integrated for the benefit of the students. Curtis stated that music effectively taught content material and facilitated classroom transitions. She specifically noted that

music facilitated learning in the areas of phonemic awareness, phonics, vocabulary, fluency, comprehension, and concepts about print.

The studies in this section indicate that music participation has strong potential to positively influence literacy skills. The last three studies concentrate on preschool and elementary school aged students. As this is an age when much literary development is happening, these studies have positive implications for use in the early childhood classroom. The study by Register (2001) has positive implications for English language learners and students needing speech services.

The next section of chapter three concentrated on the relationship between music and mathematics and spatial skills, skills that are used in the higher mathematics and sciences. Rauscher et al. (1997) established a significant positive relationship between keyboard training and spatial-temporal skills. The use of a control group strengthened the design of this study. Limitations of the study included short lessons (only ten minutes). Also, keyboard students received more practice time than the control group, creating an unequal control situation.

Rauscher & Zupan (2000) continued their previous research with a study that demonstrated music training in a public school environment having a positive effect on the spatial-temporal reasoning skills of kindergarten children. The lack of analysis between the different types of musical instruction made it difficult to determine whether the keyboard instruction or another type of musical instruction, or a combination of musical activities caused the positive effect. This study established group keyboard training, rather than solely individual training, to be an effective treatment. This has

positive implications for the classroom environment in which individual lessons are not possible.

Bilhartz et al. (1999) found a relationship between music training in the early childhood classroom and improvement in high cognitive test scores and abstract reasoning, visual imagery, and sequencing strategies. The longevity of this study (one full year) gave strength to the results. This study also revealed a link between test scores, income level, homework completion, and parental involvement. Students with lower economic status experienced less parental involvement, less homework completion, and lower test scores than students of higher economic status. This study would have been stronger with the addition of a control for the Hawthorne effect and maturation.

Brochard et al. (2004) determined that improved visuospatial skills, skills that are beneficial in mathematics and the sciences, may be related to music training. Their findings were not strong, however, and a small sample size further weakened their results. In addition, the correlational design of this study made it difficult to determine whether the small positive results were due to music training or to other confounding factors. A lack of information about the socioeconomic or ethnic background of the participants made it challenging to generalize this study to other populations.

In an experimental study, Hanson (2003) investigated the effects of literacy-based Kodaly music instruction on the spatial and verbal skills of kindergartners and found no significant relationship. Hanson asserted that Kodaly music instruction had no negative effects on spatial skills and that the students' musical skills improved dramatically as a result of instruction.

Graziano et al. (1999) conducted a study which integrated training in a math video game developed to teach spatial-temporal skills, with piano keyboard training, in order to increase spatial temporal skills. Analysis of their study results indicated improved math spatial-temporal reasoning scores, specifically in fractions and proportional math. The inclusion of a control group that controlled for the Hawthorne effect strengthened this study. Participants of this study previously received below average scores. This indicates that the integration of the math video game and music may have positive implications for other below average learners.

Vaughn (2000) established a link between music involvement and high standardized test scores in the area of mathematics in a meta-analysis of 25 studies. The correlational studies indicated a modest relationship between voluntary music study and mathematics, although causality cannot be established because the study design did not control for other factors that may have influenced results. Her analysis of experimental studies in which participants received music instruction revealed a small causal association between music participation and improved mathematical scores, although the small number of studies limited the generability of these results. The meta-analysis of background music revealed quite small but positive effects.

In a meta-analysis of 15 experimental studies, Hetland found a consistent relationship between music and spatial-temporal tasks, giving evidence to the argument that music instruction leads to improved spatial-temporal skills in school-aged children. The study of music notation as well as individual lessons had particularly strong significant effects. Her analysis found no relationship between music training and general intelligence and a small relationship between music training and spatial recognition, spatial memory, and

spatial visualization. Heltand's meta-analysis has some limitations due to the relatively small sample size. Also, because each of the experimental studies used different types of musical training, it was impossible to determine whether one type was more effective than another in enhancing spatial-skills.

The studies in this section examined the effects of musical activities on mathematics and spatial skills. Many of these studies used keyboard instruction. The visual nature of the keyboard may help students to connect visual concepts to spatial concepts. Graziano et al. (1999) addressed this when she stated, "We focused on piano keyboard lessons rather than lessons on other instruments because the keyboard gives a visual-linear representation of the spatial relationships between pitches….it is therefore easier to use the piano to teach important musical concepts such as intervallic relationships, which are spatial in nature. Furthermore, we feel that coupling visual information with aural information might assist the neural pattern development relevant to ST operations" (p. 140). While research into the effects of keyboard instruction and cognitive skills initially focused on individual lessons, Rauscher & Zupan (2000) determined that group keyboard lessons in a classroom setting also had a positive effect.

The fourth section of chapter three investigated the effects of background music on the classroom. Lewis (2002) conducted a study in which first graders took part in reading curriculum with classical background music and without background music. Students showed significant improvement on tests assessing the C.A.R.E. curriculum, which focused on sound identification, but received scores significantly lower for the regular classroom reading curriculum. Results of the study indicated a small relationship between background music and sound identification but study limitations such as a lack

of control group for the Hawthorne effect or maturation, weaken these results. Lewis concluded by stating that background music did not inhibit learning of the C.A.R.E. curriculum. She also asserted that a loud music volume may have caused the negative results for the regular classroom curriculum. Overall this study did not lend support to the argument that music instruction facilitates academic progress and memory.

Hallam & Price (1998), conducted trial sessions in which students with emotional and behavioral challenges completed math problems with background music and without background music. Results of their study revealed significant positive associations between music and mathematics performance in four out of seven trials, and non-significant positive results in the remaining trials. Researchers found no negative associations between background music and mathematical achievement. A small sample size that cannot be generalized to other populations, as well as a lack of control for maturation and for the Hawthorne effect limited the implications of these results. Without these controls researchers could not determine whether background music or other factors caused the improvement in behavior. Taking these limitations in mind, this study offers small evidence that calming background music may positively affect mathematical scores, and behavior of students with behavioral issues.

Anderson et al. (2000) inquired into the effects of classical background music on spelling test scores. Results of this study indicated that student spelling test scores and report card grades increased after the introduction of background music. The researchers reported that students demonstrated greater enthusiasm for the subject and fewer off-task behaviors. As in the Hallam & Price (1998) study, the limitations of this study, including lack of control group and controls for maturation and the Hawthorne effect lessened the

implications of the results. Also, while some ethnic diversity existed among the participants of this study, they were mainly from middle class backgrounds. Because middle class students could potentially have more exposure to classical music than students of other economic backgrounds, the results of this study may not be easily generalized to other populations.

Carlson (2004) integrated listening to classical music with relaxation in a study which used a vibroacoustic chair to improve reading performance. According to Carlson, students who took part in reading activities while sitting in the vibroacoustic chair showed up to two years advancement in their word recognition skills and three years in reading comprehension. In this study Carlson demonstrated the potential relationship between sitting in a vibroacoustic chair and improved reading skills. Further research into the mixed effects of music along with relaxing physical effect could substantiate the relationship between the combination of music and relaxation, and reading improvement. Limitations to this study include a small sample size, lack of a control group, and lack of controls for maturation and the Hawthorne effect. Due to a lack of correlations made, it cannot be determined whether the positive test scores were a result of the music or the physical movement of the chair – the vibrations themselves could have been what caused the results.

The last section of chapter three focused on the authentic relationship that students have with the music in their lives and how music can be used in the classroom to facilitate a learning environment. Shields (2001) explored whether at-risk youth would benefit from music instruction and mentorship by the classroom teacher. Test analysis determined that at-risk youth did not benefit from this relationship in non-musical ways,

although student interviews revealed that music participation brought feelings such as pride and happiness. Shields noted that some music teachers could not handle the disruptive behaviors of some of the at-risk students. This indicates that music teachers may not be equipped with the specific training needed to mentor at-risk youth.

McGovern (2000) investigated how an elementary school with a relatively high at-risk and low-income population used music as an educational and behavior management tool. In this qualitative study McGovern found that music to be used effectively for skill learning, motivational, and classroom management. Student interviews revealed that students responses to the techniques used varied. The majority of the students indicated that background music playing during instructional time was not helpful.

Lum et al. (2007) conducted an ethnographic study to examine the sonic surrounds and natural music soundings of a culturally diverse elementary school community. The researchers concluded that music is natural and integral to the school environment and can be used to facilitate authentic learning.

Shehan et al. (2007) examined the responses of high school students to an essay contest entitled “Ban the Elimination of Music Education in Schools”. Responses indicated that music involvement brought many benefits in the areas of identity formation, emotions, social relations, and life skills. Students mainly responded positively about music opportunities in school but several replied that they would like instruction in non-classical instruments such as guitar and bass to be available, as well as composition classes. The results of this study are not easily generalizable to other populations due to the lack of social, economic, and ethnic information about the respondents.

Classroom Implications

Many classroom implications can be taken from the results of the research articles examined in chapter three. Curtis (2007) stated, "Teachers are encouraged to re-evaluate the classroom environment and note opportunities during the school day when music can be integrated within the context of an instructional event to heighten the engagement of students in literacy learning" (p.215). There are exciting implications for the use of music to enhance the classroom in regards to learning in the areas of literacy and mathematics.

In the area of literacy, songs can be used as a way to enhance vocabulary, to facilitate retention of information through the use of repetition, to practice print concepts, and to deliver content and increase comprehension. Songs can be used as a means towards vocabulary exploration and comprehension. Teachers and students can make up new words for songs and make up their own songs to practice word meaning. Fun songs can be created using different nouns and adjectives. Word play and rhyme can be incorporated into songs or chants. In a study by Curtis (2007) teachers played classical music and then asked students to describe the music in words. This activity can help students begin to put abstract feelings, emotions and imagination in words. Repetition of words facilitates memory retention. Songs can be a fun way to use repetition. Butzlaff (2000) was referring to this when he stated, "when students learn the lyrics to a song they may engage in reading written text. The lyrics of songs are often repetitive and hence predictable" (pg. 167). Catchy tunes will stick in students' minds and help them remember information. In a study by Register (2001) young students learned a new song each week; they drew illustrations of the song and put together a song book. This sort of

activity can facilitate the learning of print concepts. Music can be used to deliver content and provide listening experiences that can lead to increased comprehension.

The positive relationship between music and mathematics has implications for the classroom. Research indicated that music participation enhanced skills in mathematics and the sciences. Rauscher & Zupan (2000) explained the relationship between music and mathematics when she stated, "Playing a melody involves reconstructing a pattern in which the elements, the notes, are organized in a highly specialized spatial-temporal code" (p.217). Research indicated that piano instruction facilitates mathematical learning. Most classroom teachers do not have access to pianos or keyboards. Because keyboard instruction has been shown to facilitate learning of mathematical and spatial concepts, especially in young learners, teachers may want to purchase small, one-octave xylophones for their classrooms. With one octave many of the mathematical relationships in music such as fractions can be taught. Mathematical concepts such as fractions and proportions can also be taught through the use of rhythm. Rhythm instruments do not have to cost the classroom teacher a dime. Students can use their hands and bodies to make rhythms. Old cans and bottles can be used to make drums and shakers. Teachers can show students how rhythms can be broken into equal parts just like fractions. Hetland's (2000) meta-analysis found that notation training produced particularly strong results in mathematical skills. Teachers can teach beginning notation in the classroom. While the keyboard is ideal for the study of notation, rhythm can be an excellent medium through which to study notation. Other instruments such as the recorder can be used as well.

Music can be used in other ways besides the areas of literacy and math. Music is a great way to explore other cultures. Teachers can introduce students to a country that they are studying by first introducing the music from that country. Teachers can help students from minority cultures feel comfortable by playing music from their culture in the classroom. Teachers should ask students before doing this to assure that it won't make them feel uncomfortable.

Music can be used to facilitate classroom transitions. Students can be taught a song to sing when they are transitioning from one activity to the next.

Teachers can perform a song, rhythm, or chant that students will repeat when it is necessary to capture their attention. For younger students, songs can be used to help them learn a routine. Teachers can teach students good morning songs, clean-up songs, and goodbye songs to help students effectively transition to appropriate activities.

Educators must proceed with caution when introducing background music into the classroom environment. Although background music in the classroom may benefit some learners, the research presented in this paper does not offer strong associations. When using background music in the classroom, teachers need to be aware of the reactions of their students. Some students find background music to be distracting. Much research has been done investigating the effects of classical music in the classroom. The tempo of some Baroque music matches that of the heart in a relaxed state. Some students may not be familiar with this type of music and could find it jarring. Teachers can experiment with different types of music in the classroom. They should take the ethnic background of their students into account and endeavor to play music that appeals to all students. If background music is played during instruction, it should be quiet enough so that students

can hear directions. Teachers can experiment with using background music for different types of instruction.

A study conducted by Carlson et al. (2004) in which a vibroacoustic chair was used to facilitate relaxation and academic achievement has implications for the classroom. Most teachers cannot afford to have a vibroacoustic chair but they can find other ways to integrate music with relaxation techniques. Teachers can provide students with a corner to sit and study in with quiet music playing and a rocking chair or another type of relaxing furniture such as a swing.

A study by Wallick (1998) determined that no negative effects were found due to pull-out strings instruction. Teachers should work to facilitate pull-out instrumental classes. Teachers can give music instruction to students that are not involved in pull-out programs while the students are gone.

A study by Fitzpatrick (2006) revealed a relationship between the use of music in the classroom and improved test scores for low-income students. Teachers working with low-income populations can incorporate music into the curriculum for the benefit of these students.

Teachers can recognize the importance of music in students' lives. They can lead students to authentic learning situations by encouraging the musical soundings that students make.

Implications for Further Research

The relationship between music, cognitive development, and an enhanced educational experience is ripe for further research. More research with larger sample sizes and diverse participants is needed to strengthen and solidify the relationship.

A study by Register (2001) had positive implications for English language learners and students receiving speech support. Further quantitative research into this relationship would help to solidify the evidence that music is beneficial for this population. Register's study also found positive implications for integration of literacy and music in the classroom. More research is needed to investigate the integration of music and academic areas.

The meta-analysis performed by Vaughn (2000) illustrated the need for experimental research in the area of music and math. The implications of her large correlational meta-analysis were weakened because the cause of improved mathematical and spatial skills was not determined. Experimental studies that can control for confounding variables are needed to determine causational results that can be generalized to other populations. Further research on the effects of other types of music instruction besides keyboard would be beneficial.

Further research into the mixed effects of music along with relaxing physical effect could substantiate the relationship between the combination of music and relaxation, and reading improvement. Research should be done to determine the effects of other types of music besides classical. More studies are needed with diverse populations and low-income populations so that findings can be generalized to more areas.

Future quantitative studies exploring the effects of music should include controls for the Hawthorne effect because the extra attention that students receive with music instruction may have just as much effect as music instruction. Controls for maturation and other factors such as the quality of instruction at a particular school are needed as well. Without these controls, the researcher is unable to determine whether the improvement is due to the use of music, or to other factors.

The combined results of qualitative and quantitative studies, brings depth and strength to the relationship between music and the classroom. Qualitative research brings authentic experience and insight to the issue while quantitative research brings the certainty of cold, hard data. Future research combining these two types of research would be beneficial.

As the body of research seeking to prove whether or not music participation enhances cognitive abilities, academic achievement, and the school environment grows, further research to investigate the specific ways in which music can be effectively integrated into the classroom to enhance the above qualities would be helpful and refreshing.

Summary

Chapter one of this paper introduced an inquiry into the relationship between music participation and enhanced cognitive development, academic achievement, and school environments, and described the recent controversies and trends that exist within the professional literature that examined this inquiry. Chapter two presented some of the historical context that led to the inclusion of music into the public school environment as well as to the current interest in the relationship between music and the intellect. Chapter three explored the research base in the areas of working memory and test performance,

literacy, math and spatial skills, background music in the classroom, and using music to create a meaningful and productive school environment. Results of the combined studies found that, although small, a positive relationship does exist between music participation and cognitive development, academic achievement, and an enhanced school atmosphere. Findings investigating the effects of background music were weak reflecting very small, if any relationship between listening to music and academic achievement. Chapter three of this paper summarized the findings of the research. It then offered suggestions for the use of music in the classroom and ways to integrate the use of music into the school environment, and gave recommendations for further research. Although small, the relationship between music and learning is exciting.

In today's educational environment, educators need to find creative strategies to meet the needs of the diverse body of students in the United States of America. As this chapter illustrated, there are many ways to incorporate the use of music into the classroom. Music is an integral aspect of human nature that touches our intellect and our emotions. There is no doubt that the lessons learned through the study and exposure of music are valuable to the creation of a successful school environment and the cognitive development of today's public school students.

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