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**Mozart Effect: Exploring the Relationship Between Classical Music and  
Improvement in the Spatial-Temporal Cognitive Abilities of Elementary School  
Children**

**Dissertation**

**Presented in Partial Fulfillment of the Requirements for the Degree of**

**Doctor of Philosophy**

**Lynn University**

**By**

**Michael J. Ader**

**2008**

Order Number: \_\_\_\_\_

**MOZART EFFECT: EXPLORING THE RELATIONSHIP BETWEEN  
CLASSICAL MUSIC AND IMPROVEMENT IN THE SPATIAL-TEMPORAL  
COGNITIVE ABILITIES OF ELEMENTARY SCHOOL CHILDREN**

Michael J. Ader

Lynn University, 2008

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## ACKNOWLEDGEMENTS

If there is one thing that 30 years of law enforcement has taught me, it is that music is a most important thing. The dichotomy between these two contradictory passions has always helped to keep my world in equilibrium. Fortunately, my family and the schools of my youth supported participation in music programs. The research associated with this topic as well as exposure to one school's music program only served to reinforce my personal belief that the study of music is as important to contemporary students as it was in decades past.

First of all, I must acknowledge the persistent and relentless efforts of my committee chairperson, Dr. Adam Kosnitzky. Without his unflinching and dependable support, I would not have completed this program. Secondly, I must acknowledge the extraordinary efforts of my additional committee members, Dr. Ann Crawford, and Dr. Ernie Vendrell. Their support and contributions to this project were significant and very much appreciated. I would also like to acknowledge the participation and meaningful suggestions provided by my faculty reader, Dr. Roberta Rust.

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## ABSTRACT

Mozart Effect: Exploring the Relationship Between Classical Music and Improvement in  
the Spatial-Temporal Cognitive Abilities of Elementary School Children

Michael J. Ader

Dissertation Chair  
Adam Kosnitzky, Ph.D.

The purpose of this study was to learn if classical music stimuli can be used to enhance the thinking abilities of children as measured by a cognitive testing instrument. A comparison of classical music exposure and student achievement was conducted to specifically ascertain if music of varying types had an effect on measurable intelligences (especially spatial-temporal intelligence), as measured by the Naglieri Nonverbal Ability Test (NNAT). An exploration of the theoretical and empirical literature regarding the improvement of cognitive abilities of elementary school aged children was examined to identify if exposure to arts education produced measurable gains which could facilitate academic success. In addition, this study identified contemporary research trends, gaps in the current literature, and areas for future scholarly inquiry.

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## CHAPTER I

### Introduction

According to a Phi Delta Kappan public opinion poll, 80% of the respondents believed that a mandated emphasis on public school testing in mathematics and English will lead schools to offer a reduced emphasis on arts education subjects (Rose and Gallup, 2003). Arts education programs are at risk within primary and secondary schools due to current state and federal testing mandates which directly impact local funding issues, class size and curricular direction (Conrad, 2006). In addition, the unintended consequences of eliminating or reducing arts education in public schools are cause for concern (Eisner & Day, 2004). The outcomes achieved through music education represent two schools of thought. These are the influence of music education on academic success (Hodges & O'Connell, 2005), and the psychological enhancements that music can make on personal development (Chamorro-Premuzic & Furnham, 2004).

Contemporary research has shown an increase in the reporting of a link between cognitive performance and music education (Hanna, 2007). Academic literature has indicated that exposure to classical music prior to testing has produced measurable temporary cognitive improvements (Fitzpatrick, 2006). Furthermore, an extended curriculum can lead to an increase in spatial and temporal reasoning skills (Shaw, 2004). This phenomenon often cited as the 'Mozart Effect' has spawned several theoretical aspects of music education and the relationship of this learning to non-arts subjects and personal development (Colwell, 1992; Hetland & Winner, 2002). There are reports of enhanced performance in reading and mathematics (Carlson, Gray, & Thompson, 2004; Edelson, & Johnson, 2003), the relationship of brain functioning to abstract cognitive

skills (Rauscher, Shaw, & Ky, 1993), the significance of spatial/temporal reasoning for advanced mathematics (Petress, 2005), and ultimately, the role of educational responsibility (McCarthy & Goble, 2002).

For example:

- In a 2004 study conducted by Carlson, Gray, & Thompson, (2004), music used to induce relaxation in third grade readers, produced a two to three grade level improvement in reading,
- Chamorro-Premuzic and Furnham (2004) investigated the relationship between the arts, personality and judgment and found that art judgment was significantly related to both personality and intelligence,
- Kemmerer's (2003) instruction in auditory perception positively impacted the reading abilities of early elementary aged children,
- In a study of fourth graders, Haley (2001) discovered that band members who had received instrumental instruction performed better than non-instrumentalists in math achievement,
- Matthews (2001) found that the incorporation of the arts into reading did improve the reading skills of upper level elementary students, but not lower ones,
- Whitehead (2001) conducted research on the Orff-Schulwerk instructional method (music curriculum emphasizing performance improvisation over traditional rote fundamentals) and found a correlation between participating middle and high school students and increased mathematics scores,
- Duke (2000) offered that music and arts training in general is an "integral and fundamental aspect of human communication and expression", and a necessary

component of “understanding culture and society while teaching auditory and visual discrimination”, (p.6).

- Neuharth (2000) indicated that music participants have higher reading scores, but no improvement in mathematics, while Kluball (2000) offered that instrumental experience provided higher achievement in mathematics and science, but not in reading,
- Rauscher (2000) found that kindergarteners improved in a measure of spatial/temporal intelligence after four months of musical keyboard training,
- Cheek (1999) compared eighth graders mathematics scores on the Iowa Test of Basic Skills (ITBS) and discovered higher scores among student that had instrumental training for two or more years, with keyboard students having the highest scores,
- Gardiner (1996) discovered that elementary aged students who participated in an arts curriculum, performed better in mathematics than their peers following a two year study,
- Trent (1996) indicated that sixth through twelfth graders who participated in instrumental school programs had higher scores on standardized tests than non-instrumentalists.

Successive studies explored whether exposing students to varying styles of classical music or music educational training can produce a measurable cognitive spatial/temporal effect (Shaw, 2004). Furthermore, the effects of music on social competencies and personal development have also been studied (Deasey, 2002). In review of these suppositions, the consequences of a reduction or elimination of fine arts

programs on student learning and socialization is a concern (Hetland & Winner, 2002; Johnson & Memmott, 2006). The interest related to the effectiveness of music education and cognitive improvement must also include factors outside the realm of spatial-temporal thinking (Grandin, Peterson & Shaw, 1998), and unintended effects of music education (Johnson & Memmott, 2006). These issues included the allocation of scarce resources, Florida's A+ Plan, Florida Comprehensive Assessment Test, No Child Left Behind (NCLB) and Adequate Yearly Progress (AYP), class size reduction mandates, language-analytic vs. spatial-temporal learning, and the unintended consequences or non-musical outcomes of arts education (Conrad, 2006).

### **Allocation of Scarce Resources**

In 2006, President George W. Bush mandated a 3% across the board cut in public school funding within the 2007 federal budget (Carter, 2006). This was evidenced by the cancellation of 51 Department of Education programs which are listed as "results not demonstrated", (USDOE, "Not Performing Programs, What Does Not Performing Mean?" n.d.). Florida faced legislative cuts in property taxes which had a detrimental impact on the funding of public schools (Tait, 2007). The Florida Lottery contributed to primary and secondary education as well as undergraduate college scholarships, but funding is not allocated in a reoccurring amounts. Since the lottery's 1986 inception, approximately 8 billion of the estimated 17 billion collected by the lottery has been returned to Florida's 67 counties for use in education, construction and maintenance of public primary and secondary education institutions (Department of Lottery, State of Florida, 2007). Florida received assistance for public education in the form of a Public Education Capital Outlay and Debt Service Trust Funds which obtained funds from

utility services telecommunications services and a portion of general sales taxes (Florida Department of Revenue, 2007). With no state income tax and proposed property tax reductions in the amount of \$7.2 billion, Florida faced cuts to its public school budget (Goodnough & Sexton, 2007).

School districts across the nation have been subjected to pending legislation advocated by lobbyists acting under the organization known as First Class Education. The movement known as the 65% Rule, provided that 65% of a state's educational budget will be allocated for classroom education with the remaining 35% going for support functions such as administration, counseling, library services, health services, professional development, curricular development, and transportation (Cooper & Hequet, 2005; Byrne, 2007; Mandlawitz, 2007). Arts education is included in the description of the National Center for Education Statistics definition of classroom education, but the underlying belief is that cutting support services will adversely impact what is seen as non-essential coursework (Weiss, 2006).

Funding gaps within public education have been a concern on both the student level as well as teacher compensation (Campbell, 2006). Present funding gaps between lower and higher performing schools are as much as \$2000.00 per student in states such as New York and Illinois (Carey, 2004). While current federal mandates compel the assessment of children through standardized testing, concerns have revealed that inadequate funding allotted for testing programs will not be sufficient at the state and local level (Borkowski & Sneed, 2006). Florida maintained a trend to divert public education funding to rural counties under the District Sparsity Supplements, impacting rapidly growing urban areas, while employing District Cost Differentials to provide

funding for salaries in regions which claim higher costs of living (Florida Department of Education, FLDOE, Florida Education Finance Plan, FEFP, 2007).

### **A+ Plan**

The 1999 implementation of the Florida A+ plan provided student standards for the Florida Comprehensive Assessment Test (FCAT) performance in grade three through eleven (Rosenthal, 2007). There are four main provisions comprising the A+ Plan. First, public schools receive letter grades on an A to F scale based upon a point system. The grades are posted publicly so that parents can become better informed as to the success of their child's school. Schools receiving letter grades of D or F become eligible for district financial assistance as well as personnel to aid in school improvement. Schools showing improvement or rated as grade A schools, become eligible for rewards under School Recognition Funds. A minimum of 95% of the student body must be tested for the school to be eligible for a grade of A. In order for the school to be eligible for any other grade, 90% of the student body (excluding certain special education students) must be tested. Schools are automatically rated as grade F if less than 90% of students are tested. As a final provision, schools rated below grade A, which do not meet the provisions of Adequate Yearly Progress for 2 years in a row, will receive a one letter grade reduction (FLDOE, 2007).

According to the Florida Department of Education (2007), students attending a school receiving an F grade rating for two out of four consecutive years, have the ability to transfer to another school rated as grade C or better. Parents have the choice to let their students remain at a failing school where schools can receive \$1000.00 in funding per student for additional staffing and tutors.



Third, schools are required to create a pupil progression plan which articulates standards for promotion to the next grade, ending social promotion. This is done by specifying proficiency in mathematics, science and reading, and by considering student testing results on the FCAT. Students receiving a 1 on FCAT reading in the third grade are considered for non-promotion and students who receive less than 300 on the 10<sup>th</sup> grade FCAT cannot graduate from high school and are tested again in the 11<sup>th</sup> grade (FLDOE, 2007).

Fourth, the A+ Plan raised standards for teachers by mandating minimum certification and recertification requirements, improving and raising standards for admission to colleges of education, the establishment of teacher training institutes, and a reward system for high performing educators. Schools which are rated as A or improve by one letter grade can receive school recognition funds in the amount of \$100.00 per student. These rewards are used for teacher bonuses, school enhancements, and student incentives. This reward system is reflected as a 5% increase in salary for teachers whose students show outstanding improvement, as measured by learning gains from the Florida Comprehensive Assessment Test (FCAT) (FLDOE, 2007).

### **Florida Comprehensive Assessment Test (FCAT)**

The FCAT is a competency test used by the State of Florida to measure student learning which is based upon state mandate to improve educational standards (FLDOE, 2007). The FCAT is offered to students from the third through the eleventh grade and is composed of norm-referenced and criterion-referenced testing components, which measure performance in the academic subjects of mathematics, reading, writing and science. Rosenthal (2007) noted that Performance on the FCAT is a requirement for

graduation including twelfth grade participation if prior standards are not met. The tests are given annually to students and measure grade level standards in the following subjects. Students are tested in grades three through eleven. In grades four, eight and ten, students take both an essay and writing test. Mathematics and reading are tested in grades three through ten. Science is tested in grades five, eight and eleven (FLDOE, 2007).

### **No Child Left Behind (NCLB) and Adequate Yearly Progress (AYP)**

The “No Child Left Behind” Act was passed by Congress in 2002. This law required changes in the current systems of public education. Highlights of the law included increased standardized testing for students. This translated to yearly testing in the subjects of reading and mathematics in grades three through eight, and a minimum of one time testing for tenth through twelfth graders. In addition, a greater number of students must improve each year to meet specific standards set by each State. Schools that do not progress will be selected for changes which include staffing, curriculum, or funding enhancements (FLDOE, 2007; U.S. Department of Education, USDOE, 2007).

As a component of NCLB, states are mandated to evaluate public school student performance through what is termed Adequate Yearly Progress, (AYP). This is done to determine whether individual schools, school districts, and states have made progress toward academic achievement standards. The AYP report measured the participation and performance of subgroups, based upon race, ethnicity, socioeconomic status, disabilities and proficiency in English. If a school does not make Adequate Yearly Progress, there is a provision for students to receive additional help. Also, if a child’s Title One School (schools where 40% of students receive free or reduced lunch), failed to make Adequate

Yearly Progress for two consecutive years, the student can elect to transfer to a higher performing school. The goal of NCLB is 100% proficiency by the end of the 2013-2014 school year (Winn, 2006).

### **Class Size Reduction Mandates**

The Florida State Constitution was amended in 2002 to reduce class size by a minimum of two students each year and for the 2010-2011 academic school year, the maximum number of students in core classes cannot exceed the following guidelines. Pre-kindergarten through third grade students are limited to an average of 18 students per class, fourth through eighth grades are limited to an average of 22 students, and ninth through twelfth grades are limited to an average of 25 students (FLDOE, 2007). Beginning in the 2006-2007 school year, the average number of students per class was constitutionally redirected from a district average to a school average, causing the yearly reduction mandate to be missed. As a result of this directive, schools have been upgraded with construction projects and additional classrooms to ensure compliance. Past renovation have resulted in the reassignment of music rooms as regular classrooms, forcing music teachers to float between classes, carrying their equipment on carts (Jeffries, 2001).

Based upon the NCLB federal budget allotment, funds for class size reduction were not available within the proposed allocation (Borkowski & Sneed, 2006). This caused enormous budgetary concerns at the state and local levels. The number of additional classrooms necessary for NCLB mandatory compliance resulted in a further need for the additional hiring of educators. This was exacerbated by teacher attrition, retirements and the mandated departure of educators completing Florida's Deferred

Retirement Option Plan, (DROP). Finally, it would appear that class size reduction has been the most expensive method available for affecting standardized testing scores (Normore & Hon, 2006).

### **Language-Analytic vs. Spatial-Temporal Learning**

Language-analytic methods of instruction are commonly used within the public education curriculum. The specific use includes a lecture type of environment where information and solutions are of a quantitative nature (Shaw, 2004). Spatial-temporal learning involves thinking mentally in advance about a problem's solution, much like chess (Grandin, Peterson, & Shaw, 1999; Schmidt, 2006). Language-analytic methods seem to neglect the mental imaging necessary to solve proportional mathematics or engineering equations. Research has suggested that there is a cognitive connection between music education and music exposure as they relate to the mental visualization used to understand these types of problems (Foley, 2006; Palmer, 2001). In mathematics education, Cheek & Smith (1999) found that enhancing the spatial/temporal cognitive abilities of the brain can lead to an unintended improvement in visually dependent arithmetic such as geometry.

### **Non-Musical Outcomes to Arts Education**

Eng (2004) discovered that the introduction of an arts curriculum into public education enhanced learning in both related and unrelated subjects. Researchers found that by including music programs which teach both performance and theory into an educational curriculum, there were measurable improvements in the student's cognitive abilities relating to spatial-temporal exercises, proportional mathematics, language and vocabulary skills, and behavioral issues (Lesuik, 2000; Fitzpatrick, 2006). The

elimination of arts programs (especially music programs) can adversely affect the specific course proficiencies which the federal government seeks to measure (Kardish & Wright, 1986; Podlozny, 2000; Hetland & Winner, 2002; and Johnson & Edelson, 2003).

### **Legal Cases in Education**

The Federal Government's initial intention for public education was that certain governmental incentives were afforded to the States for the purpose of educating the masses. Following U.S. independence, the federal government offered enticements in the form of educational grants and land ordinances to encourage State governments to begin setting up their own public education systems. The federal government's initial belief was that in order for the United States to be recognized as a civilized society, formal educational systems needed to be in place for the both the public good and to enable the U.S. to compete economically within a global market (Alexander, 2001).

Educational malpractice has evolved recently within U.S. courts to describe the failure of learning institutions to provide students with basic or reasonable skills. Watts (2005) indicated that although several cases have been filed on behalf of students alleging this malpractice, the courts are reluctant to rule in favor of students (or plaintiffs) citing that this would open a floodgate of similar allegations resulting in a paralysis of schools. The trend of standardized testing, which has resulted in the elimination of class time for fine arts programs, has led to allegations of negligence on the part of schools. The deliberate reduction or elimination of fine arts programs has led 21 states to consider refusing federal NCLB funding (Chapman, 2004).

## **Theoretical Framework**

There are two main theories most frequently used to describe the enhancement of cognitive skills related to music exposure. These are the Trion Theory and the Yerkes-Dodson Law. The Theoretical Framework began with the Trion model or Trion Theory of cognitive functioning which proposed that the connection between music and spatial-temporal learning is developed from Vernon Mountcastle's columnar network of neurons, and Hebb's Learning Rule, which proposed changes in synaptic strength (Shaw, 2004). In Mountcastle's design, the cortex of the human brain is composed of columns of neurons (Shaw, Silverman, & Pearson, 1985). Conversely, the Yerkes-Dodson Law is based upon the premise that unique individuals perform differently at varying levels of stimulation, and that certain types of arousal will increase performance to a maximum point where continued cognitive arousal diminishes performance (Hetland & Weiner, 2000).

### **The Trion Theory**

A link between music and spatial/temporal reasoning proposed by Leng & Shaw (1985) was based upon the work of Mountcastle (1978). In his work, Mountcastle's columnar organizational principal offered that the cortex is composed of columns of neurons which are further subdivided into mini-columns. In his model, Mountcastle proposed that these columns can be stimulated into spatial-temporal firing patterns within the mini-columns. Leng & Shaw (1991) proposed the name trion due to the three levels of firing among neurons. Inside this network of trions, Mountcastle (1978) indicated that there are inherent, stable and periodic firing patterns which can be used for both memory and higher learning. Leng and Shaw (1985; 1991) suggested that exposure to music can

stimulate these firing patterns in an organized manner, enhancing the brain's ability to think spatially.

In addition, the work of Hebb (1961) proposed that there is a repetition effect found when subjects performed an auditory-verbal serial recall task in which one particular series of digits was repeated every third trial. In his experiment, recall of a repeated sequence increased over non-repeated sequences, though most participants were not aware of the repeated section. This is referred to in the literature as the Hebb Repetition Effect or the Hebb Learning Cycle and is periodically researched for its relationship to long-term learning (Couture & Tremblay, 2006). Shaw's combination of the Trion Theory and the Hebb Learning Rule form the basis of the Mozart Effect's consequence in spatial-temporal learning.

### **The Yerkes-Dodson Law**

The Yerkes-Dodson Law or Cognitive Arousal Theory is based upon the premise that different individuals will perform better at differing levels of arousal and that individuals will seek their particular level of optimum arousal. The Law itself stated that arousal (the physiological and psychological state of being awake) increased performance up to a maximum point, at which time further arousal impairs performance. This translated to the belief that easy tasks require a high level of arousal for motivation, and that more complex tasks require a low level of arousal for motivation. Put another way, monotonous or repetitive tasks require more effort than complex tasks which are enjoyable. In complex tasks, the performance was seen as curvilinear (inverted U) while in simple tasks, the relationship was linear (Yerkes & Dodson, 1908).

## **The Mozart Effect**

The Mozart Effect is described as a measurable connection between music and mathematics using human cognition to stimulate the spatial and temporal areas of the brain (Rauscher, Shaw, & Ky, 1993; Petsche & Etlinger, 1998; Cheek & Smith, 1999; Hetland, 2000; Rauscher & Zupan, 2000; Ivanov, & Geake, 2003; Bangerter & Heath, 2004; Edelson & Johnson, 2004; Eng, 2004; and Shaw, 2004). There is significant controversy associated with the research on classical music and its effect on measurable IQ scores, mathematics proficiencies, reading skills, and social competence.

As a preliminary premise to this study, prior researchers indicated four concerns regarding the Mozart Effect. These concerns are listed as; the debate surrounding the belief that exposure to classical music can enhance intelligence, the question of whether this effect is found in only one of Mozart's compositions, to what extent personal and demographic differences in research subjects might offer varying results, and that teachers may not be interested in the causes of the effect, just the nature of whether the effect is temporary or permanent (Ivanov & Geake, 2003). The Trion model proposed that columns of neurons can be stimulated to fire in patterns by frequency, enhancing the spatial-temporal thinking of individuals. The Arousal theory proposed that auditory stimulation enhances alertness and thus, increased cognitive performance. Finally, according to Parsons, Fox & Hodges (1998), magnetic resonance imaging has shown that the language of music does not reside in one particular section of the mind (such as the right side), but is "widely distributed into locally specialized regions of the brain", (p.4).



## **Purpose of the Study**

The purpose of this study was to explore the measurable cognitive benefits of exposing primary school aged children to classical music as measured by the Naglieri Nonverbal Ability Test (Naglieri, 1996) published by Harcourt Assessment. Previous researchers claimed that exposing students to certain types of classical music enhanced cognitive abilities for a measurable duration. Improvement in the spatial-temporal skills of students can lead to a greater understanding and increased performance of higher forms of mathematics and engineering, which require a mental visualization for the solution to problems (Cheek & Smith 1999; Palmer, 2001; and Foley, 2006). The ultimate goal of this study is to determine if listening to classical music can improve the thinking abilities of children and whether these enhanced abilities can translate to measurable cognitive gains.

## **Significance of the Study**

Research has shown that the connection between music education and cognitive improvement in public schools is of substantial importance (Hodges, 2000; Hanson, 2003; Johnson & Edelson, 2003; Petress, 2005; Carter, 2006; Fitzpatrick, 2006; Foley, 2006; Johnson & Memmott, 2006; Elpus, 2007; Hanna, 2007; Stewart, 2007). This research focused on an epistemological search to develop knowledge, which may be lacking in this area due to conflicting information regarding arts education and its effect on both academic performance and personal growth. A successful contextual understanding of music education and cognitive improvement is an important step in the enhancement of student learning (Campbell, 2002). Appropriate academic learning and

the socialization of students ultimately enables schools to delivering superior instructional services to the community (Chamorro-Premuzic & Furnham, 2004).

Arts education programs including music programs are at risk in public schools due to state and federal testing requirements which directly impact local funding issues and curricular direction (Conrad, 2006). Growing trends in mandated testing and class size reduction affects the amount of time and space available for enrichment programs (Eisner & Day, 2004). Also, the reduction or elimination of music education programs affects the positive unintended consequences of arts education, which appear to influence both academic performance and personal development (Hetland & Winner, 2002; Hodges & O'Connell, 2005).

### **Hypothesis**

This study investigated whether there is measurable cognitive improvement among second through fifth graders following an exposure to classical music of varying type, as measured by the NNAT test of non-verbal reasoning. In addition, this project explored the relationship of personal/structural factors (age, gender, grade level, past musical training, enjoyment of the music), as they related to the students' performance on the NNAT. Based upon these considerations, the principal investigator hypothesized the following:

1) Second through fifth grade students who are exposed to the music of Mozart will experience a greater improvement in cognitive performance than students exposed to Shostakovich or silence. ( $\alpha = .05$ )

2) Personal/structural factors (demographic, academic, and music experience) have a relationship to cognitive performance in second through fifth grade students who are exposed to classical music. ( $\alpha = .05$ )

### **Research Questions**

Based upon the previous hypothesis, the following research questions were developed:

- 1) Will there be a difference in the students' performance on the NNAT between the groups who experienced Mozart and those who experienced Shostakovich or silence?
- 2) Based upon the personal structural factors, will there be differences in the student's performance on the NNAT following the musical experience or silence?
- 3) Based upon the personal structural factors, will there be no differences in the student's performance on the NNAT following the musical experience or silence?

### **Research Design**

The researcher chose the NNAT as a pre and post test measurement following a differing musical experience of varying duration or silence. The first research question, "Will there be a difference in the students' performance on the NNAT between the groups who experienced Mozart and those who experienced Shostakovich or silence?" Will be analyzed using Multiple Analysis of Variance (MANOVA), with post hoc comparisons for evaluation of the total NNAT score. The individual component scores of the NNAT will be analyzed using one-way MANOVA as compared with performance

in the subject areas of Pattern Completion (PC), Reasoning by Analogy (RA), Serial Reasoning (SR), and Spatial Visualization (SV).

The second question, “Will the differences in personal/structural factors have an effect on the NNAT performance, following the musical experience or silence?” Will be analyzed using MANOVA to evaluate the comparison of the multiple variables and measures of central tendency (mean, frequency distributions, and variability).

The third question, “Will the differences in personal/structural factors have no effect on the NNAT performance, following the musical experience or silence?” will be analyzed using MANOVA to evaluate the comparison of the multiple variables and measures of central tendency (mean, frequency distributions, and variability). The research was quasi-experimental in nature and was comprised of a pre-test post-test design using a convenient sample with three treatment groups (Mozart, Shostakovich, and silence). The four grade levels of the school were broken up into three groups by individual grade for a total of 12 groups. The researcher randomly selected one group from each grade level of the convenience sample, to experience one of the three conditions, (Mozart, Shostakovich, or silence). The researcher initially visited the school where the first NNAT test was given. The researcher again visited the school 14 weeks later, where the musical treatment was given along with the personal/structural factor survey and the second NNAT examination. The time spent with the students was minimal and represented a brief snapshot of student performance as recorded by Scores on the NNAT instrument.

## **Scope and Delimitations**

The participants were confined to second through fifth graders from one Southeast Florida private school. The majority of students came from families of moderately high to high socioeconomic status (SES). The researcher initially administered the NNAT pre-test. Twelve weeks later, the researcher provided the musical treatment along with the personal/structural factor survey and the NNAT post-test. The NNAT was group administered according to class and all students of the four grade levels were invited to participate in the research. This quasi-experimental cluster study utilized a sample of convenience and the investigator could not anticipate mortality from either the experimental or control groups. The NNAT instrument has not been used previously in this type of research design.

## **Definitions**

Classical music: A categorical reference to western European art music of the era between the years 1750 and 1820 and is represented by the compositions of Wolfgang Amadeus Mozart, Franz Joseph Haydn, Ludwig Van Beethoven, their contemporaries and successors. This era falls between the baroque and romantic styles of western music.

Cognitive Arousal theory: Based on the ideas that different individuals perform better at different levels of arousal and that every individual seeks to find their optimum level.

This indicates that simple tasks require a high level of arousal to get the motivation to do them, while difficult tasks require low arousal to get the proper motivation.

Counterpoint: Two or more melodies are woven together to make a tightly knit complex musical texture where musical expressiveness is derived from a dissonant interval followed by a consonant interval, leading from tension to relaxation.

Epistemological: The branch of philosophy that studies the nature of knowledge, including presuppositions, foundations, extent and validity.

Mozart Effect: The ideas of Shaw and Leng which led to the behavioral experiments testing the prediction that music exposure and training at an early age would enhance the ability to use pattern development in spatial-temporal reasoning. Shaw and Rauscher reasoned that if the experiments with preschool children would produce long-term enhancements from music training, perhaps listening to specific music would produce a short-term enhancement of spatial-temporal reasoning.

Music theory: A field of study which describes the elements of music and musical structure. This includes methods for analyzing and composing music. The study of music theory explores the relationship between musical notation and performance.

Neuropsychology: A branch of psychology which describes how the structure and function of the brain relate to psychological processes.

EEG: Electroencephalogram: the neurophysiologic measurement of the electrical activity of the brain by recording from electrodes placed on the scalp or, on the cortex.

MEG: Magnetoencephalography-a noninvasive method of brain mapping which provides spatial discrimination by measuring the associated magnetic fields emanating from the brain.

Music education: The National Association for Music Education created nine content standards for music education called the National Standards for Music Education which were adopted in 1994. These are listed as:

1. Singing, alone and with others, a varied repertoire of music.
2. Performing on instruments, alone and with others, a varied repertoire of music.

3. Improvising melodies, variations, and accompaniments.
4. Composing and arranging music within specified guidelines.
5. Reading and notating music.
6. Listening to, analyzing, and describing music.
7. Evaluating music and music performances.
8. Understanding relationships between music, other arts, and disciplines outside the arts.
9. Understanding music in relation to history and culture.

Praxis: the process of putting theoretical knowledge into practice.

Spatial-Temporal reasoning: The two types of reasoning: spatial-temporal (ST) and language-analytic (LA) are crucial to how we think, reason, and create. LA reasoning would be more involved when we solve equations and obtain a quantitative result, (sometimes associated with right-brain thinking). As noted, ST would be involved, in chess when we have to think ahead several moves, (sometimes associated with left-brain thinking).

Sunshine State Standards: Approved by the Florida Board of Education in 1996 to provide expectations for student achievement in Florida. This format was chosen to provide flexibility to school districts in designing curriculum based on local needs, however as Florida moves toward greater accountability for student achievement at each grade level, the Sunshine State Standards have been further defined.

Trion model: Leng and Shaw's proposed causal link between music and spatial-temporal reasoning. The model was developed from Mountcastle neural columnar organization principle. The main component of spatial-temporal reasoning may be the ability of the

columnar networks to recognize the symmetry relations among cortical firing patterns in a sequential manner.

WISC: Wechsler Intelligence Scale for Children (for 7-16 year olds)

WPPSI: the Wechsler Intelligence Scale for Children (for 3-7 year olds)

## **Organization of the Study**

### Chapter 1

Chapter 1 is comprised of the initial research concern. The chapter begins with an abstract, methodology, and major findings. Theoretical framework is discussed, followed by purpose, significance, assumptions, and justifications. The chapter concludes with the research questions, research design, scope and delimitations, definitions, and organization of the study. Chapter 1 provides an introduction to the study, touching on major references found within the literature and the theoretical basis for past related works.

### Chapter 2

Chapter 2 provides an introduction to the information found within the literature. Topics such as No Child Left Behind, the Florida Comprehensive Assessment Test, and legal issues impacting education are discussed. In addition, music education curriculum, learning theories, and non-musical outcomes or the unintended consequences of music education are explored. The chapter concludes with literature related to educational challenges, the dissolution of fine arts programs, a history of western music, cognitive functioning as stimulated by music, and the spatial/temporal effects of music. The chapter concludes with a look at the “Mozart Effect” literature.

### Chapter 3

Chapter 3 provides the methodology for the study, with a look at purpose, population, sampling plan, eligibility, and setting. The study’s instrumentation,



reliability, validity, analysis and evaluation are also articulated. The testing instrument used for the study is the Naglieri Non-Verbal Ability Test (NNAT), which is a measure of non-verbal cognitive ability. The instrument is given to the subjects as a pre-test, with a post-test following a music treatment. The subject's personal/structural factors are also collected to allow for further analysis of the research questions.

Chapter 4 includes a description of the research participants as well as the results of the NNAT pre-post testing, and the information gathered from the personal structural data sheet. In the main analysis, this chapter provides a descriptive analysis of the NNAT subcomponents or clusters, as well as the performance of the students who received differing post test treatments. A look at the original research questions and corresponding test scores is compared and contrasted with the initial research hypotheses.

Chapter 5 presents a summary of findings, theoretical considerations, conclusions and study limitations. In addition, this chapter offers recommendations for future research, this study's implications for future practice and final thoughts concerning the importance of arts education, including music education as a necessary component of a well rounded education.

## CHAPTER II

### REVIEW OF THE LITERATURE

The review of the literature is focused on the relationship of music education to cognitive improvement and the impact of arts education reduction in public school students. Researchers have documented increases in cognitive testing scores following a classical music listening experience, or music education curriculum (Shaw, 1993; 2004). The phenomenon often cited within the literature as the 'Mozart Effect' commenced with the research of Rauscher, Shaw, and Ky (1993), who discovered an increase in intelligence scores following the exposure of students to a specific work by Mozart. The resulting supplemental research which grew from this initial study, gave rise to several theoretical aspects of musical training. These include increased performance in science and mathematics, and the relationship of brain functioning to the development of abstract cognitive skills, identified as spatial and temporal reasoning.

Learning methodologies were examined including the relationships of psychology to educational practices, with attention given to the Developmental Learning style of Piaget and the spatial/temporal, language/analytic approaches to modern education. The proposals of Leng and Shaw's Trion Model (1991) as compared with Nantais and Schellenberg's Arousal Model of cognitive learning (1999) were explored within the literature. In addition, an examination of the potential for affecting cognitive function in this manner revealed positive considerations for successful learning as well as the moral and ethical considerations incumbent upon educators to maintain an open mind in exploring non-traditional educational possibilities. This investigation focused on an

epistemological search to develop knowledge, which may be lacking in this area due to the perpetuation of misinformation.

The direct effects and successes of music education programs in public schools are additionally dependent upon other considerations. These concerns include the allocation of scarce resources, Florida's A+ Plan, Florida Comprehensive Assessment Test, No Child Left Behind (NCLB) and Adequate Yearly Progress (AYP), class size reduction mandates, language- analytic vs. spatial-temporal learning, and the unintended consequences of arts education (Conrad, 2006).

### **Review of the Literature**

#### **Allocation of Scarce Resources**

In 2006 President George W. Bush mandated a 3% across the board cut in public school funding within the 2007 federal budget (Carter, 2006). This is evidenced by the cancellation of 51 Department of Education programs which are listed as "results not demonstrated" (USDOE, "Not Performing Programs, What Does Not Performing Mean?," n.d.). Florida faced legislative cuts in property taxes which had a detrimental impact on the funding of public schools (Tait, 2007). The Florida Lottery contributed to primary and secondary education as well as undergraduate college scholarships, but the funding is not allocated in a reoccurring amount. Since the lottery's 1986 inception, approximately 8 billion of the estimated 17 billion collected by the lottery has been returned to Florida's 67 counties for use in education, construction and maintenance of public primary and secondary education institutions (Department of Lottery, State of Florida, 2007). Florida received assistance for public education in the form of a Public Education Capital Outlay and Debt Service Trust Funds which obtained funds from

utility services, telecommunications services and a portion of general sales taxes (Florida Department of Revenue, 2007). With no state income tax and proposed property tax reductions in the amount of \$7.2 billion, Florida faced cuts to its public school budget (Goodnough & Sexton, 2007).

School districts across the nation are subject to legislation advocated by lobbyists acting under the organization known as First Class Education. The movement known as the 65% Rule, provided that 65% of a state's educational budget will be allocated for classroom education with the remaining 35% going for support functions such as administration, counseling, library services, health services, professional development, curricular development, and transportation (Byrne, 2007; Cooper & Hequet, 2005; Mandlawitz, 2007). Arts education is included in the description of the National Center for Education Statistics definition of classroom education, but the underlying belief is that cutting support services has adversely impacted what is seen as non-essential coursework (Weiss, 2006).

Funding gaps within public education are a concern on both the student level as well as teacher compensation (Campbell, 2006). Present funding gaps between lower and higher performing schools are as much as \$2000.00 per student in states such as New York and Illinois (Carey, 2004). While current federal mandates compel the assessment of children through standardized testing, concerns reveal that inadequate funding allotted for testing programs will not be sufficient at the state and local level (Borkowski & Sneed, 2006). Florida maintained a trend to divert public education funding to more rural counties under the District Sparsity Supplements, impacting rapidly growing urban areas, while employing District Cost Differentials to provide funding for salaries in regions

which claim higher costs of living (Florida Department of Education, FLD DE, Florida Education Finance Plan, FEFP, 2007).

### **A+ Plan**

The 1999 implementation of the Florida A+ plan provided student standards for the Florida Comprehensive Assessment Test (FCAT) performance in grade three through eleven (Rosenthal, 2007). There are four main provisions comprising the A+ Plan. First, public schools receive letter grades on an A to F scale based upon a point system. The grades are posted publicly so that parents can become better informed as to the success of their child's school. Schools receiving letter grades of D or F become eligible for district financial assistance as well as personnel to aid in school improvement. Schools showing improvement or rated as A schools, become eligible for rewards under School Recognition Funds. A minimum of 95% of the student body must be tested for the school to be eligible for a grade of A. In order for the school to be eligible for any other grade, 90% of the student body (excluding certain special education students) must be tested. Schools are automatically rated as F if less than 90% of students are tested. As a final provision, schools rated below A which do not meet the provisions of Adequate Yearly Progress for 2 years in a row, will receive a one letter grade reduction.

Second, students attending a school which received an F rating for two out of four consecutive years, have the ability to transfer to another school which is rated as C or better. Parents have the choice to let their children remain at a failing school where schools can receive \$1000.00 in funding per student for additional staffing and tutors. This is a double edged concern for schools who seek to both improve their ratings, and minimize the loss of higher achieving students to better public or private schools through

opportunity scholarships, and increased healthy competition (Goldhaber & Hannaway, 2004).

Third, schools are required to create a pupil progression plan which articulates standards for promotion to the next grade, ending social promotion. This is done by specifying proficiency in mathematics, science and reading, and by considering student testing results on the FCAT. Students receiving a 1 (out of 4) on FCAT reading in the third grade are considered for non-promotion and students who receive less than 300 (out of 500) on the 10<sup>th</sup> grade FCAT cannot graduate from high school and are tested again in the 11<sup>th</sup> grade.

Fourth, the A+ Plan raised standards for teachers by mandating minimum certification and recertification requirements, improving and raising standards for admission to colleges of education, the establishment of teacher training institutes, and a reward system for high performing educators. Schools which are rated as A or improve by one letter grade can receive school recognition funds in the amount of \$100.00 per student. These rewards are used for teacher bonuses, school enhancements, and student incentives. This reward system is reflected as a 5% increase in salary for teachers whose students show outstanding improvement, as measured by learning gains from the Florida Comprehensive Assessment (FLDOE,2007).

### **Florida Comprehensive Assessment Test (FCAT)**

The FCAT is a competency test used by the State of Florida to measure student learning which is based upon state mandate to improve educational standards (FLDOE, 2007). The FCAT is offered to students from the third through the eleventh grade and is composed of norm-referenced and criterion-referenced testing components, which

measure performance in the academic subjects of mathematics, reading, writing and science. Performance on the FCAT is a requirement for graduation, including 12th grade participation if prior standards are not met. The tests are given annually to students in grades three through eleven, and measure grade level standards in the following subjects: In grades four, eight and ten, students take both an essay and a writing test. Mathematics and reading are tested in grades three through ten. Science is tested in grades five, eight and eleven (Rosenthal, 2007).

Criterion-based or criterion-referenced test scores are typically measured against the current testing group (or a set of curriculum guidelines set by the state to determine proficiency) in the subjects of reading, mathematics, science and writing. Norm-referenced test scores are measured against a predetermined standard score (such as a national standard to identify state performance against a larger educational pool) in the subjects of reading and mathematics. These standardized tests are useful in the measurement of expected aptitude and national performance, however “often are not able to assess a student’s deeper conceptual understanding or complex thinking abilities” (Dietel, 2004, para. 6). In addition, according to Booher-Jennings (2005), Texas has already engaged in what the author calls ‘educational triage’, where students on the cusp of an acceptable testing level are being tutored in classes currently allocated for arts education. Also, this type of educational focus can lead to a reduction in playground time, lock-ins for test preparation (Hirschman, Hall & Patrick, 2000), and the additional consequences of Florida’s A+ Plan.

The FCAT is a test for primary and secondary level students, given in Florida to measure accomplishment as compared to the state’s content standards identified as the

Sunshine State Standards. These Standards are indicators of what should be typical student performance. The Sunshine State Standards were developed from 1993 through 1996, and sought to enhance the complexity of educational material previously based upon a set of minimum competencies. The Sunshine State Standards include seven instructional areas consisting of language arts, science, mathematics, social studies, health and physical education, foreign language, and arts education. These instructional areas are reduced to benchmark units, which articulate knowledge, skills and content that students should be learning. FCAT testing provides a measurement of student benchmark achievement and is generally provided only within public schools.

The FCAT was developed in order to prepare students for the challenges of demanding workplaces which require advanced mathematics and science related skills, along with the need to comprehend complex written material and perform intelligible writing. The test, given in February (writing skills) and March (mathematics, science and reading), allows educational professionals to establish the success of student performance as compared against the Sunshine State Standards. The mathematics, science and reading portions of the test are developed to encourage students to evaluate and analyze material as it applies to a previously learned practical strategy. This practice is designed to compel students to go beyond the prior measurements of facts, and in the case of the writing test, to prepare an original work based upon a contemporary topic.

The FCAT is frequently newsworthy in Florida due to the fact that each public school receives a grade which is based upon student performance. School grades are used to measure both student and school accountability, as it pertains to deficiencies and corrections in instructional curriculum. The tremendous focus of the FCAT has impeded



the inclusion of arts education by monopolizing classroom time for test preparation and review (Schmidt, 2004).

### **No Child Left Behind (NCLB) and Adequate Yearly Progress (AYP)**

The “No Child Left Behind” Act was passed by Congress in 2002. This law required changes in the current systems of public education. Highlights of the law included increased standardized testing for students. This translated to yearly testing in the subjects of reading and mathematics in grades three through eight, and a minimum of one time testing for tenth through twelfth graders. In addition, a greater number of students must improve each year to meet specific standards set by each State. Schools that do not progress will be selected for changes which include staffing, curriculum, or funding enhancements (FLDOE, 2007; U.S. Department of Education USDOE, 2007).

As a component of NCLB, states are mandated to evaluate public school student performance through what is termed Adequate Yearly Progress (AYP). This is done to determine whether individual schools, school districts, and states have made progress toward academic achievement standards. The AYP report measured the participation and performance of subgroups, based upon race, ethnicity, socioeconomic status, disabilities and proficiency in English. If a school does not make Adequate Yearly Progress, there is a provision for students to receive additional help. Also, if a child’s Title One School (schools where 40% of students receive free or reduced lunch), failed to make Adequate Yearly Progress for two consecutive years, the student can elect to transfer to a higher performing school. The goal of NCLB is 100% proficiency by the end of the 2013-2014 school year (Winn, 2006).

According to the U.S. Department of Education's website, No Child Left Behind (NCLB) is a federally mandated program signed into law on January, 8, 2002, which included components of an earlier law known as the Elementary and Secondary Education Act of 1965 (ESEA). The No Child Left Behind Act seeks to enact the theoretical educational components of standards-based educational reform or outcome-based education, which sought to relate high expectations and goal setting to the success of K-12 students. For reporting purposes, parents will be better informed as to the progress of their student in relation to other students at the same level, and the success of their school as compared to other State schools, including a breakdown of ethnicities and students with disabilities. Additionally, the States are mandated to prepare teacher report cards articulating the qualifications of the instructors, including their lack of specific certifications in some subject areas. Also, school districts must notify parents if schools fail the state standards of student improvement (USDOE, 2007).

Students of schools receiving poverty funding which failed to show improvements within two years will be allowed to transfer schools or receive free tutoring. Students attending schools designated as dangerous due to uncontrolled violence or drug/alcohol problems may also transfer to another educational facility. Parents and schools are encouraged to work together to develop educational opportunities for children and the schools must develop programs to facilitate parental involvement. In addition, supplemental educational services (tutoring and remedial assistance) shall be provided to students in need in the form of after school assistance, weekend classes or summer sessions. In its effort to 'close the achievement gap', the No Child Left Behind Act promotes and supports assistance in the further development of charter schools and

magnet schools, and facilitates assistance for private schools and home-schooled children. This is done by encouraging states to seek innovative techniques to enhance the education of children and be held accountable for the success or failure of these techniques (USDOE, 2007).

According to the U.S. Department of Education's website, NCLB has either four or five separate components, according to whether components are combined or listed separately. Under the four section literature, the first component of the act is based upon a stronger accountability for results. This component ensures that state educational systems are persevering to close any achievement gaps including disadvantaged students, in the pursuit of academic proficiency. This is accomplished by the reporting of the states to communities regarding the performance of their school, and promising to change systems and procedures that are not working. The second component offers more freedom for states and communities. This allows the states enhanced flexibility in the manner in which funds are allocated, and districts the freedom to address local concerns. The third component provides that proven and effective educational methods developed through scientific research, be incorporated into educational practice. This allows instructional programs which are scientifically based to be utilized as needed in the targeting of specific need. The fourth component of parental choice allows parents to seek alternative school for their children if their assigned school does not meet state standards for a minimum of two consecutive years. If the assigned school fails to meet state standards for three consecutive years, students become eligible for tutoring and after-school learning as necessary. Additionally, if the student's school is particularly

violent or if the student is the victim of a violent crime while attending school, the student can seek transfer to a safe school within their district (USDOE, 2007).

Under the five component listings, NCLB recognizes a component for teacher quality. This equates to teachers having a minimum of a bachelors degree, and being able to pass a general subject knowledge test at the elementary level, or for middle and high school teachers, complete a subject area test within their area of educational expertise, and have either an undergraduate major, a graduate degree, related coursework, or some type of related subject area certification (USDOE, 2007).

The next component for NCLB is a measure of student testing where students are tested in mathematics and reading in grades 3 through 8, plus one time in high school. For the years 2007 and 2008, a science testing component has been added within grades 3-5, 6-9, and 10-11 (USDOE, 2007). Provisions are contained within the testing that compels students who perform unsatisfactorily to be retested during the following year. Failure to perform can postpone graduation.

The third component is one of parental involvement, which ensures that parents are provided insight into their child's education. This is accomplished by ensuring that parents are informed as to their child's specific progress and programs which are available for any needed assistance. This is managed through a sharing of responsibility between parents and schools. The five subcomponents of the act are listed as general issues related to parental involvement, the parental involvement responsibilities of state educational agencies, the responsibilities of local educational agencies, the responsibilities of schools and, the responsibilities of local educational agencies and

schools to build parents' capacity for becoming involved in improving their child's academic achievement (USDOE, 2007).

The fourth component is one of scientifically based research. Under this component, research strategies for staff development and classroom components include large group studies of a quantitative nature in favor of qualitative or ethnic and geographic pupil studies. The act indicates information obtained within these studies may be in conflict with current accepted or learned educational methods (USDOE, 2007).

The fifth component of NCLB is one of school choice. Under this provision, students are afforded an opportunity to change schools when attending an underperforming school (including transportation), and must be offered additional educational services. In addition, the school must notify parents of additional services available for their children, and of teacher's qualifications (USDOE, 2007).

### **Class Size Reduction Mandates**

This program first initiated by President Bill Clinton in 1999 proposed the allocation of funding to hire 100,000 new teachers. President George W. Bush's NCLB sought to improve the quality of teachers through the use of block grants. In November 2002, voters in Florida approved a plan requiring schools to limit the number of students in public classrooms from kindergarten through high school. Florida voters assumed that smaller class sizes allow for more individualized student instruction and better instructional control of classes, leading to higher achievement (Kennedy, 2007). Class size reduction is popular with parents and students, but the costs of new construction and staff hiring are straining local and state school budgets. Federal incentives addressing

class size do not cover the entire cost of establishing smaller classrooms, compelling some school districts to divert funding resources from other areas (Kennedy, 2007).

The Florida Association of District School Superintendents (FADSS) proposed in its 2003-2004 budget report that the estimated cost of class size reduction would be 27 billion over an eight year implementation period. The resulting need for instructional staff was estimated to be 91,000 additional teachers within the following 4 years, equating to 68% of the state's current instructional staff (FADSS, 2004). The 2007 FADSS report articulated class size reduction as a major concern to school districts by noting the "impact of individual school districts' debt service accumulation, equity, growth, change in capacity due to Class Size Reduction, impact/availability of portable classrooms, concurrency, property/casualty insurance needs and secondary school reform (FADSS, 2007).

The 2002 Florida State Constitution amendment on class size reduction provided that for each new school year, class size should be reduced by a minimum of two students, and for the 2010-2011 academic school year, the maximum number of students in core classes cannot exceed the following guidelines: Pre-kindergarten through third grade students are limited to an average of 18 students per class, fourth through eighth grades are limited to an average of 22 students, and ninth through twelfth grades are limited to an average of 25 students (FLDOE, 2007). Beginning in the 2006-2007 school year, the average of students per class was constitutionally redirected from a district average to a school average, causing the yearly reduction mandate to be missed. As a result of this directive, schools are being upgraded with construction projects and additional classrooms to ensure compliance. Past renovation resulted in the reassignment

of music rooms as regular classrooms, forcing music teachers to float between classes, carrying their equipment on carts (Jeffries, 2001).

Based upon the NCLB federal budget allotment, funds for class size reduction are not available within the proposed allocation (Borkowski & Sneed, 2006). This caused enormous budgetary concerns at the state and local levels. The number of additional classrooms necessary for NCLB mandatory compliance resulted in a further need for the additional hiring of educators. This is exacerbated by teacher attrition, normal retirements and the mandatory separation of educators participating in Florida's Deferred Retirement Option Plan, (DROP). Finally, it would appear that class size reduction is the most expensive method available for positively affecting standardized testing scores (Normore & Iton, 2006).

### **Language-Analytic vs. Spatial-Temporal Learning**

Language-analytic methods of instruction are frequently used within public education curriculum. The specific use includes a lecture type of environment where information and solutions are of a quantitative nature (Shaw, 2004). Spatial-temporal learning involves thinking mentally in advance about a problem's solution, much like chess (Grandin, Peterson, & Shaw, 1999; Schmidt, 2006). Language-analytic methods neglect the mental imaging necessary to solve proportional mathematics or engineering equations (Shaw, 1999). Research has suggested that there is a cognitive connection between music education and music exposure as they relate to the mental visualization used to understand these types of problems (Foley, 2006; Palmer, 2001). In mathematics education, Cheek & Smith (1999) found that enhancing the spatial/temporal cognitive

abilities of the brain can lead to an unintended improvement in visually dependent arithmetic such as geometry.

Edelson and Johnson (2004) discovered that by using melodic or percussive rhythm to establish meaningful contexts in pattern thinking, children can better prepare themselves for the numerical patterns found in mathematics. This was accomplished by encouraging the children to analyze patterns to establish rules, communicate these rules with words, and then predict the next pattern. This is the basis for the Spatial-Temporal Animation Reasoning (STAR) animation reasoning program developed by Shaw (2004). Johnson and Edelson (2003) also stated that a spatial-temporal approach to classroom learning through the integration of music and mathematics produced a rhythmic foundation for learning “proportional reasoning and geometry” (p.1).

According to Grandin, Peterson, and Shaw (1999), language-analytic and spatial-temporal reasoning are both important components of thinking. The language-analytic approach for education provides that students receive the necessary information to answer a question. Spatial-temporal reasoning involves, the mental rotation of objects in space and time, looking at sequences and patterns, and thinking ahead. Leng and Shaw (1991) stated in their research that even very young students can benefit from a spatial-temporal approach in the area of proportional reasoning.

Reimer (1999) indicated that music in school may be de-emphasized due to the belief that music itself was of an emotional nature and not subject to academic standards of an intellectual or cognitive nature. This conclusion was drawn from the work of the philosopher Rene Descartes who stated that mathematical pursuits need to be free from unreliable human emotions. Reimer examined the effects of musical training as



compared with the National Standards for Music Education. These nine standards consist of singing, instrumental performance, improvisation, composition, reading / notating music, music listening, evaluating music and performance, understanding the relationships of music to other disciplines, and the relationships of music to history and culture (NAME, 2007). In his look at the National Standards of Music Education in comparison with various research studies, Reimer found that the first six components of the Standards have been measured as improvements in spatial-temporal learning. The final three components can best be measured through language-analytic learning. Reimer is concerned that the lack of an exclusive spatial-temporal approach to music education can lead to a reduction in areas of music education not deemed critical for spatial-temporal reasoning.

### **Non-Musical Outcomes of Arts Education**

Eng (2004) discovered that the introduction of an arts curriculum into public education enhanced learning in both related and unrelated subjects. Researchers found that by including music programs which teach both performance and theory into an educational curriculum, there are measurable improvements in the student's cognitive abilities relating to spatial-temporal exercises, proportional mathematics, language and vocabulary skills, and behavioral issues (Fitzpatrick, 2006; Lesuik, 2000). The elimination of arts programs (especially music programs) can adversely affect the specific course proficiencies which the federal government seeks to measure (Hetland & Winner, 2002; Johnson & Edelson, 2003; Kardish & Wright, 1986; and Podlozny, 2000).

Non-musical outcomes achieved through music education can be divided into two categories. These are the influence of music education on academic success (Hodges and

O'Connell, 2005) and the psychological enhancements that music can make on an individual's personal development (Chamorro-Premuzic and Furnham, 2004). The exposure of musical training can have positive effect on test scores in a variety of situations. For example, sixth through twelfth graders who participated in instrumental school programs had higher scores on standardized tests than non-instrumentalists (Trent, 1996). Neuharth (2000) indicated that music participants have higher reading scores, but no improvement in mathematics. Conversely, Kluball (2000) found that instrumental experience provided higher achievement in mathematics and science, but not in reading. Finally, Haanstra (2000), and Hines (2000), found no differences between music students and non- music students. There has been some reported success with the use of the Kodaly method of music training in early elementary education (Olson, 2003).

According to the National Association for Educational Assessment (NAEA, 2005), 38% of students nationally were reading below average, while 23% were rated as proficient. The state of Florida was rated at 35% below average, also with 23% rated as proficient (NAEA, 2005). This indicates a concern for a large number of current students. While some research indicated that attempts to relate music instruction to enhanced reading achievement were unsuccessful (Kemmerer, 2003), instruction in auditory perception did positively impact the reading abilities of early elementary aged children (Anvari et al, 2002).

The National Center for Educational Statistics (NCES) 2005 ratings for mathematics revealed the following information. For the fourth grade national student level, 21% performed below the basic level with 30% performing as proficient. For the state of Florida, 18% of fourth graders performed below the basic level with 31% rated as

proficient. Additionally, for eighth graders, the national percentage was 32% below basic level with 23% rated as proficient. In Florida, 35% of eighth graders rated below basic and 21% were rated as proficient (NCES, 2005).

In a study of elementary aged children, Gardiner (1996) discovered that students who participated in an arts curriculum performed better in mathematics than their peers following a two year study. In a study of fourth graders, Haley (2001) found that band members who had received instrumental instruction performed better than non-instrumentalists in mathematics achievement. Whitehead (2001) conducted research on the Orff-Schulwerk musical instructional method (music curriculum emphasizing performance improvisation over traditional rote fundamentals) and found a correlation between participating middle and high school students and increased mathematics scores. A 2005 study conducted by Carlson, Hoffman, Gray, and Thompson, found that music used to induce relaxation in third grade readers produced a two to three grade level improvement in reading comprehension, word recognition, and accuracy as measured by the Reading Inventory for the Classroom and the San Diego Quick Assessment Test.

In 1999, Cheek compared eighth graders mathematics scores on the Iowa Test of Basic Skills (ITBS) and discovered higher scores among student that had instrumental training for two or more years with keyboard students having the highest scores. In the examination of music and spatial/temporal enhancement, Rauscher's 2000 study found that kindergarteners improved in a measure of spatial/temporal intelligence after four months of keyboard training. Edelson and Johnson (2003; 2004) discuss music and its relationship to spatial/temporal reasoning by offering suggestions for the integration of mathematics and music by using pattern activities such as naming, graphing, and

translating patterns along with songs emphasizing serial order. This is done through the sorting and classifying of rhythms and instruments, solving problems through ratios and combinations, and using basic music theory to divide and subdivide wholes.

Adler (1982) offered the educational belief that incorporating music and art into seemingly unrelated subjects would enhance learning. Matthews (2001) found that the incorporation of the arts into reading did improve the reading skills of upper level elementary students, but not lower ones. Gregory (1988) discovered that music used to teach mathematics produced improvements over control groups, however Omniewski (1999) discovered no achievement differences among seconds graders exposed to an “arts infusion group” (Hodges and O’Connell, 2005, p.16).

In his article, “The Other Mozart Effect”, Duke (2000) stated that much time and attention is paid to research examining the effects of music training only on academic achievement. This author draws attention to the unintended consequences of music exposure which go beyond budget allocation dilemmas that may enhance a very small measurable academic spike. In the spirit of the ‘chicken and egg’ scenario, Duke (2000) points out that it is unclear as to whether smart students take more advanced classes or whether advanced classes produce smarter students. Duke proposed that music and arts training in general is an “integral and fundamental aspect of human communication and expression”, and a necessary component of “understanding culture and society while teaching auditory and visual discrimination” (p.6). In concert with this philosophy, Chamorro-Premuzic and Furnham (2004) investigated the relationship between the arts, personality and judgment. These researchers found that art judgment was significantly

related to both “personality (low extraversion and conscientiousness) and intelligence (high IQ)” (p.3).

### **Legal Cases in Education**

Historically, the U.S. founding fathers assumed that it was necessary for the Federal government to take a leadership role in the promotion of education. It was thought that citizens had a societal obligation to better themselves through the implementation of instructional learning. Following independence, the State governments were not yet unified in their approach to the education of children and the federal government sought to offer assistance in the form of land ordinances (plots of land reserved for public schools), and other indirect methods of encouragement. The Federal Government maintained its distance from State control by “offering educational grants offered to promote general welfare, laws relating to commerce, and court restrictions designed to protect individual freedoms and rights” (Alexander, 2001, p.68).

In the Federal government’s relationship of commerce to State education outlined in *Gibbons v. Ogden* (1824), the Supreme Court indicated that commerce goes beyond the exchange of goods, to include advances in “society, labor, transportation, intelligence and care” (Alexander, 2001, p.69). Coupled with the innovations of scientific discovery, the Supreme Court included education within the commerce provision of the Constitution in an effort to exert some control over the States. The notion of innovation related to education for the purposes of trade is associated with the belief that a well educated population is vital for the success of the United States as a nation in the arena of international commerce. This provision allowed the Federal Government to offer guidance and assistance to the States for educational improvement. The implementation

of the 10<sup>th</sup> Amendment (offering power to the states in the absence of Constitutional mandates), and the case of *Gibbons v. Ogden* (1824), provided for the functioning of State controlled educational systems.

While the Federal government's proposition implied that education is both a personal obligation and necessary condition of an economically successful society, the States sought improvement in existing systems to meet the demands of an evolving society with various court rulings shaping present systems. According to this history of educational law, it is apparent that while the states are directed by the Federal government to provide a quality education, the discretion to offer enhanced arts learning lies within the power of individual states. A complete educational experience (including arts education) points to the Founding Fathers initial intention that education is an obligation of civilized humanity, and will ultimately lead our society to a successful presence within future global design.

The recent court-related term 'educational malpractice' has evolved in conjunction with mandated testing for student promotion or successful graduation from high school. According to Watts (2005), there has not been a successful claim upheld by the State courts for educational malpractice, though many torts have been filed on behalf of students who progressed through various school systems while performing below average for their grade level. Examples include a student who graduated from high school without the ability to fill out a job application, a student who was promoted through the system with an undiagnosed learning disability, a foreign born student who failed to perform sufficiently by not learning English, a student with dyslexia who was grouped with developmentally disabled students for seven years, graduates from a

vocational school who were unable to secure employment, parties injured while receiving treatment at university medical schools, and a whole host of cases involving a general failure to teach.

The issue of educational malpractice is a three-pronged concern. First, the courts have insinuated that the consideration of the cases ruled favorable to the plaintiffs, would result in a flood of similar cases disrupting local educational systems both functionally and financially. Second, there is a belief that the bulk of responsibility for learning lies with the learner and the learner's parents, not with the school system (including transferring to a better school or actively seeking challenging classes). Finally, there are notable differences between failure to teach and failure to learn (Watts, 2005).

In Trent's (2003) "diagnosis as treatment" (p.1), the current practice of standardized testing is viewed as both the measure of the problem and the solution to the problem. Poor performance by students (and schools) on standardized tests leads to more testing and the time-consuming test preparation that accompanies this process. This causes a reduction in educational topics not directly related to standardized testing, and the potential for educational malpractice. According to Watts (2005), the elements for educational malpractice include 'duty, breach, injury, and causation'. This translates into a duty to teach coupled with a failure to fulfill that duty, an inability on the part of the student to succeed, and a determination that the school was negligent in the performance of its duty. A deliberate reduction or elimination of arts education has led to the consideration of 21 states to refuse federal NCLB funding (Chapman, 2004).

### **A Variety of Learning Theories and Methods**

According to Leonard (2002), the text "Learning Theories, A-Z" articulates definitions for 532 separate learning theories pertaining to adult learners and primary / secondary educational students. This listing of theories is identified with one of five learning paradigms categorized as behaviorism, cognitivism, constructivism, humanism, and organizational learning.

Kelly (1997) indicated that the greatest advances in 20<sup>th</sup> century education came from the field of psychology and not education. Innovators such as David Kolb and Malcolm Knowles offered theories which supported learning. Kolb proposed in his theory of experiential learning that a learning cycle comprised of four elements (Smith, 2001). These elements consist of concrete experience, observation and reflection, forming abstract concepts, and testing in new situations (Smith, 2001). Experiential learning is composed of skills immediately acquired in a relevant setting, and while learning real-life events (Smith, 2001). According to Smith (2001), Kolb indicated that the learner can enter the cycle at any one of the four points, but that knowledge transfer may ultimately suffer.

Kolb's theory of experiential learning offers students the opportunity to apply new skills immediately in a relevant setting, encountering the task directly instead of by theoretical application. The learning is presented by those with real life experiences, instead of through a theoretical application (Smith, 2001). Honey and Mumford (as cited in Zwanenberg, 2000) discuss Kolb's work and assign identifying names to each of these four stages (activitists, theorists, pragmatists, and reflectors), indicating that different people perceive the world in different ways, and prefer to learn in different ways (Zwanenberg, Wilkinson, & Anderson, 2000). Reynolds (2002) indicated that someone



might be gifted in one area but lacking in basic skills in another area. A critique of Kolb's work on experiential learning include the implications that the purposes, goal, choices and decision-making are lacking in the education of the student, and that performance is based upon the student's self evaluation, and not standards of behavior (Kelly, 1997).

The differences between learning theory and technical learning are further identified by Swanson (as cited in Zemke, 2002) who states, "training is about creating expertise, not simply pouring knowledge into people" (Zemke, 2002, p.86). The formal application of basic learning skills is still applied to the quest of developing expertise or that learning is knowledge, free to develop independent thought. Technical learning is more about skills development, and the ability to perform a task useful for a job.

"Learners need to see the big picture of where they are going, they need to learn the details of the performance, and they need to test themselves on the whole performance in the end" (Swanson as cited in Zemke, 2002, p.87).

The potential range of individual diversities within contemporary schools is a modern concern. While an important and growing component of present society, the difficulty of addressing successful learning of ethnically diverse students is a complex problem. It has been demonstrated that students of similar backgrounds learn differently. It is necessary to develop effective methods of dealing with learning as perceived by students of varying ages, cultures, languages, educational achievement, and intelligence. For example, it is customary for an instructor to impart specific and uniform information to various students during technical training. The instructor is not interested in delivering special information to a select few; the same information is given to all. To further

complicate matters for an instructor, compliance to anticipated mandates accelerates the teaching of diverse students. The learning perspective encourages legal compliance and training, but also “encourages active participation in finding better, faster or more efficient ways of compliance beyond those legally mandated” (Dass & Parker, 1999, p.71).

The growing cultural diversity of an educational organization and its employees need to be considered in the development of any instructional program. It is not unusual to encounter students whose first languages do not include English. The languages of Spanish, French (Creole), Patois, Portuguese, and a multitude of dialects for each can easily be found among multicultural students. Schools need to perpetuate the inclusion of these students into mainstream educational programs, ensuring a full understanding of the material and allowing for diverse cultural interpretations of the lessons. In Kubota’s (2001) interpretation of World English’s, English is a well spoken language throughout the world, with identifiable characteristics. Kubota stated that knowledge of a specific language is not only seen as power, but the lack of a firm grasp can lead to cultural prejudices. The student is viewed as incompetent if their English is not strong and the instructor risks credibility with a native English audience if his or her English is weak. To complicate matters further, a grasp of the local variety of English is necessary to identify with a specific local audience. There needs to be a best way to instruct students, while focusing on their abilities instead of language flaws and teaching instructors to be sensitive to such issues.

Lohman (2002) presented an article articulating four problem-solving skills and problem-based approaches. These approaches are “case study, goal-based scenario,

problem-based learning, and action learning” (p.243). Lohman recognized the differences in the learning models and cited the need for additional empirical studies of cognitive theory relating to problem-solving skills. In the degree of transfer desired, it is advantageous for the instructor to have a firm grasp on the diversity of the group to enhance the effectiveness of the learning process. In addition, teachers can improve their skills by identifying their least effective learning style, seeking to improve it, then seeking to improve their instructional techniques.

Learning theories can be divided into the following categories:

- Constructivism- Bruner
- Behaviorism- Skinner
- Neuroscience- McLean
- Brain-Based Learning- Caine
- Learning Styles- Lemire
- Right Brain/Left Brain Thinking- Sperry
- Communities of Practice- Lave and Wenger
- Control Theory- Glasser
- Observational Learning- Bandura
- Social Cognition- Vygotsky
- Multiple Intelligences- Gardner

### **Constructivism (Bruner)**

Constructivism is a learning philosophy which proposes that learning is based upon the notion of past experiences leading to an understanding of the present world. Based upon the individual’s perception of the world, new experiences are the basis of new learning. In constructivism, learning is portrayed as a search for individual meaning rather than rigid curriculum or solitary facts. Instruction should be non-standardized in that the learning must be geared to individual past experiences and prior knowledge, leading to a personal quest for self-improvement using a hands-on, self-critical and open-ended education (Brooks & Brooks, 1993).

### **Behaviorism (Skinner)**

Behaviorism is a philosophy of learning in which the attainment of a new behavior equates to new learning. These behaviors are categorized under the terms of classical conditioning and operant conditioning. A classical conditioning behavior (like Pavlov's dog) proposes that certain behaviors are pre-programmed by species where a specific stimulus will yield a certain response. Operant conditioning differs from classic conditioning in that reinforcement is added to the stimulus which increases the likelihood of a response being repeated (Skinner as cited in Phillips and Soltis). Utilizing the system of rewards and punishments, behaviorism attempts to influence the level of learning by reinforcing patterns of both desired and prohibited actions (Phillips and Soltis, 2003).

### **Neuroscience (McLean)**

Neuroscience is the study of the human nervous system. This includes the brain's systems of consciousness, memory, and perception as they are related to the processes which support learning. This philosophy supports three separate structures of the brain and their relationships to certain physical and mental processes. The lower (or reptilian) brain for the control of sensory motor functions, the mammalian (or limbic) brain for the control of memory and emotions, and the thinking (or neocortex) brain which controls language, cognition, and reasoning. The two major concepts of this brain science is that the brain itself is composed of flexible and repetitive non-linear neurons (unlike the present computer), and the brain's structure is ever-changing due to the brain's ability to continue to make new neural connections as a result of concentration and deliberation (McLean as cited in Kazlev, 2003)

## **Brain-Based Learning (Caine & Caine)**

Brain-based learning is a theory which dictates that if the brain is allowed to mature in a normal manner, learning will be accomplished. There is a concern within this camp that traditional education inhibits learning by discouraging or punishing the brain's natural ability to learn. According to Prigge (2002) educators are now just "beginning to recognize the importance of applying cognitive and neuroscience research and theory in the learning process", (p.237). The basis of brain-based learning are the principles of conscious and unconscious perception, focused and peripheral stimulus, rote and spatial memory, patterned and parallel learning, and that learning is both natural and physical.

It is also interesting to note that Prigge continues with the recommendation on management of the learning environment in which "music can affect pulse, blood pressure, muscle tension, and brain waves", (p.238). The author also recommends using upbeat music for transition times, and using classical or instrumental music for group work, testing, and other quiet time work. Research on music and learning has shown that "music that plays at or near 60 beats per minute improves learning and memory, actually slowing down brain waves and increasing optimum functioning", (Prigge 2002, p.238).

## **Learning Styles (Lemire)**

This philosophy offers the notion that learning is an individual process dependant upon the way students process and perceive the information offered. Learning Styles is directly dependant upon the past experiences of the individual learner with respect to environmental factors such as upbringing, heredity, and other personal influences. These diverse perceptions are categorized as concrete and abstract perceivers or as active and reflective processors. Concrete perceivers absorb information directly through personal

experience while abstract perceivers obtain information through observation. Active processors make immediate use of new information while reflective processors take time to think about it (Kolb & Fry, 1975).

### **Right Brain vs. Left Brain (Sperry)**

The right brain-left brain segmentation generally indicates that the two sides of the human brain are responsible for different styles of thinking. It also purports that specific individuals have preferences over these styles and use them in the cognitive perception of their world. The differences are articulated according to the specific brain hemispheres. For example, the right brain hemisphere is often associated with an intuitive, visually stimulated and spatial relational individual with a questioning nature and challenging time management skills. Conversely, the left brain is often associated with a verbally focused, logical individual who appreciates organization and advance planning (Sperry, 1973). Additionally, according to Sperry (1973), verbal and non-verbal cognitive ability appears to be located within the left hemisphere (verbal) and right hemisphere (non-verbal) with mainstream education along with the sciences in general, ignoring non-verbal cognitive ability. Sperry sees this as a form of societal discrimination against the brain's right hemisphere.

It has also been said that right brain individuals are more creative and left brain individuals more analytical. The literature appears to imply vast differences between the two which lie beyond a one word description. While it would seem that traditional educational systems are more in tune with a left brained approach, it is believed that the subjective and creative nature of the right hemisphere is becoming considered. It would seem beneficial for schools to emphasize a more whole brained approach to education,

infusing the components of both styles for a more rounded educational experience (Sperry, 1973).

### **Communities of Practice (Wenger)**

A Communities of Practice philosophy incorporates the process of learning as it relates to a specific community structure. The practitioners of this style believe that learning is a social phenomenon in which social learning environment is dependant upon a close relationship between schools and communities. Real knowledge is integrated in communities which share values, beliefs, languages, and practices, and actions are directly related to learning in the way that doing is a necessary component of knowing (Wenger, n.d.).

### **Control Theory or Choice Theory (Glasser)**

Control Theory philosophy indicates that learning behaviors are not directly related to lessons, but that learning is a direct result of individual need. In other words, students will not learn a specific lesson unless that lesson fulfills some individual need which is perceived as relevant by the student. This style is directly opposite of the traditional educational style and necessitates that instructors impart some message of need to students before they can be expected to internalize specific lessons (Glasser, 2006).

### **Observational Learning or Social Learning (Bandura)**

Observational learning (or social learning theory) philosophy incorporates the belief that the observation of a model can influence the behavior of the learner. These behaviors are affected by imitation, observed treatment, and later performance. The

process of observational learning are often divided into the categories of attention (observing a model's characteristics), retention (the ability to display a model's characteristics at a later time), production (possessing the necessary skills to repeat the observed behavior), and motivation (the observed positive or negative behaviors that motivate a repeat of the behaviors) (Bandura, 1986).

### **Social Cognition (Vygotsky)**

The Social Cognition approach offers the notion that culture is directly related to learning in that the specific context of an individual's cultural environment ultimately affects intellectual development. According to Vygotsky's philosophy, this cultural environment encourages both the lessons of learning and the cognitive interpretation of the lessons (or what to think and how to think). This is accomplished initially by guided problem solving, gradually transferring learning responsibility to the learner sometimes referred to as 'interpsychological and intrapsychological' with the attainment individual consciousness as the ultimate achievement of successful socialization (Vygotsky, 1978).

### **Developmental Theory (Piaget)**

Piaget's Developmental Theory is a pedagogical philosophy which purports that a child responds to environmental physical experiences through the development of 'cognitive structures'. Piaget believed that these structures developed over time to include a more complex association of cognitive functions. As a child continues to experience similar conditions, the structure remains in balance. When new experiences occur, the child is forced to develop additional cognitive structures, which intern enhances learning. He divided these developmental structures into four categories which are listed in order of age progression:



1. Sensorimotor (from birth to age 2) - where a young child builds relationships about their environment through physical interaction with objects.
2. Preoperational (from age 2-7) - where the child continues to rely upon a physical environment and abstract concepts are beyond reach.
3. Concrete Operations (from age 7-11) - With continued physical experiences, the child begins to form logical conceptualizations explaining these experiences. Abstract mathematical equations can be solved with the use of numbers rather than solely with objects.
4. Formal operations (from age 11-15) - Conceptual reasoning occurs as the child moves into adulthood (Atherton, 2007).

### **Multiple Intelligences (Gardner)**

The Multiple Intelligences philosophy proposed by Gardner supports the tenets of learning by stating that individuals perceive information according to their dominant learning style. Gardner initially offers seven (and later three additional) intelligences necessary to accommodate all learners in the perception and understanding of their world. His definition of intelligences is based upon eight specific criteria which are then based upon biological conditions, logical analysis, developmental psychology, and traditional psychological study. These intelligences are defined as:

1. Linguistic - The student's ability to use words and language,
2. Logical / Mathematical - The capacity for logical reasoning, as well as the use of numbers and the ability to recognize abstract patterns,
3. Spatial -The ability to visualize pictures and images spatially,
4. Body-Kinesthetic - The ability to control physical motion,

5. Musical - The ability to recognize sounds, auditory patterns and rhythmic structures,
6. Interpersonal - The ability to excel at personal communications and relationships,
7. Intrapersonal - The ability to be self-reflective and aware of surroundings,  
and later:
8. Naturalist - The ability to learn through experiencing the natural world,
9. Spiritual - The ability to learn through a concern for cosmic or existential issues,
10. Existential - The ability to learn through a concern with ultimate issues such as love or the meaning of life and death.

Gardner believes that these intelligences are abilities which are autonomous from other human capabilities, have a specific set of information processing rules, engage at distinct stages of development, and are rooted in historical evolution (Gardner, 1999).

Dr. Gardner writes:

In a way, I was no different. But there was one exception: When I was a youth, music in particular and the arts in general were important parts of my life. Therefore, when I began to think of what it meant to be "developed," when I asked myself what optimal human development is, I became convinced that developmentalists had to pay much more attention to the skills and capacities of painters, writers, musicians, dancers, and other artists. Stimulated (rather than intimidated) by the prospect of broadening the definition of cognition, I found it comfortable to deem the capacities of those in the arts as fully cognitive - no less cognitive than the skills of mathematicians and scientists, as viewed by my fellow developmental psychologists, (Intelligence Reframed, p.28).

### **Present Educational Challenges**

The harsh truth is that arts education when compared to other societal needs and political interests are not and will not ever be an educational or social welfare priority for state or local governments or for most people of influence. There are simply too many more pressing claims on public or private resources. Arts education advocates promise a fantastic and unattainable assortment of returns in exchange for a fantastic and unavailable span of investment, (Eisner & Day 2004, p.130).

There are many challenges affecting the present elementary educational structures within the United States. The Federal government's mandate for 'No Child Left Behind' and the succession of mandated testing has directly impacted the amount of time and space available for enrichment programs such as music and art. In many cases, fine arts programs have been squeezed out of educational systems, making way for class size reduction and increased emphasis on minimum competency testing. With the addition of academic achievement concerns, student retention rates, staffing shortages, and the court's concern with educational malpractice, music and art as viable educational tools have been de-emphasized. This analysis illustrates and analyzes concerns, while potential solutions are presented and offered as they are discovered within the literature. The analysis of the literature concludes with a synopsis, while interpretations, conclusions, and recommendations presented at the end of the review in the discussion section.

### **History and Characteristics of Musical Educational Programs**

The history of music education in the United States was initially associated with "a variety of functional values that reflected music's role in the social, physical, moral, and intellectual development of schoolchildren" (McCarthy & Goble, 2002, p. 19). Music education in schools during the first half of the twentieth century was meant to augment and reflect the ideals of a cultured and civilized society first presented in the initial founding principles of public education. Following the end of WWII, music educators turned to a branch of philosophy known as aesthetic education, which sought to modernize this topic by adding credibility and respectability to this aspect of the school curriculum (McCarthy & Goble, 2002). Historically, in an effort to present music

education to the masses, Davison (1926) stated that “if indeed, there is to be a real American democracy of music, not an aristocracy of the gifted, we must see to it that every stage of music education is carefully and skillfully constructed, especially that part upon which the entire development rests, namely, the elementary schools” (p.44). Further controversy was evidenced by early music education in this passage from a period text entitled, *Music Education in America: What is wrong with it? What shall we do about it?*, “Because the time allotted to music study is so meager, it is doubly unfortunate that music periods are generally not more profitably employed. School music-teachers devote far too much time to the technique of music and far too little to music itself” (Davison, 1926, p.45).

McCarthy & Goble (2002) stated that following the introduction of an aesthetics philosophy, music education was introduced into mainstream curriculum, validating it as a subject with serious academic content, leading to professionalized instruction. In the latter part of the 20th century, a movement emerged incorporating music education as practice rather than theory. This approach known as praxis or praxial philosophy, contrasted with aesthetic music education because the focus was upon practice rather than theory. Praxial philosophy included multi-cultural considerations rather than focusing solely upon western music as a source of musical education curriculum. This corresponded with the political civil rights atmosphere of the time and the international considerations of educational diversity.

According to Colwell (1992), music education is comprised of two distinct components; performance and non-performance programs. In performance programs, students are organized into bands, ensembles, and other groups which round out the

school community. These groups are identified as marching/symphonic bands, vocal choirs, orchestras and jazz ensembles. In the non-performance program, general education students are exposed to various concepts of music which enhance listening skills, knowledge of music history, and an introduction to music theory.

### **Educational Dissolution of Fine Arts Programs**

Schmidt (2004) indicated that “in too many schools, music is considered an optional or elective pursuit, even a completely expendable one”, (para. 6). Gardner’s child development theories propose that different children learn differently, and that some may not have the potential to grasp a one size fits all traditional educational approach. Under the present classroom system, the vast numbers of children cannot allow for true individualized considerations. Gardner indicated that profound innovations in technology are required to truly offer an individualized approach. Under the current mandate for the uniform testing of students, there is a duality within a system which both identifies the necessity for a meaningful curriculum while addressing individual needs. Case law offered help by mandating equal educational opportunities for diverse children, and defined that equal but different, is not equal at all, (Alexander, 2005).

Gardner proposed the theory of multiple intelligences and the relationships of this diversity to be considered in educational practice. Children seem to have a natural curiosity and attraction for musical experiences. The expendable nature of music under a modern educational system is a modern concern (Campbell, 2002). Campbell writes of the non academic benefits of music education which include community involvement skills, visual and aural recollection, emotional expression, stress reduction, and the ability to interact with compassion. Campbell (2002) additionally stated that “Music is

responsible for an increase in neural connections which stimulates verbal skills, while offering increases in reading and math skills, and memorization”, (p.4). Gardner (2003) compared musical intelligence and it’s relationship to spatial intelligence and linguistic ability while lending credibility to Campbell’s propositions that music enhances learning, physical health, and healing.

The consequences of the dissolution of fine arts programs are illustrated in the following timeline. A 1994 study measuring 7,500 university level students found that those majoring in music scored highest in reading as compared with students majoring in biology, chemistry, mathematics and English (Phi Delta Kappa, 1994). Lower socio-economic status students exposed to music education during grades 8-12 showed greater improvement in mathematics, reading, history, and geography test scores, than students who did not receive music education classes (Gardiner, Fox, Jeffrey and Knowles, 1996). The U.S. Department of Education data indicated that students who report consistently high levels of involvement in instrumental music during the middle and high school years show significantly higher levels of mathematics proficiency by grade 12 (Catterall, Chapleau & Iwanaga, 1999). In addition, listening to certain music appeared to enhance the brain’s ability to perform cognitive tasks involving mental rotation (Hetland, 2000). In 2001, the College Entrance Examination Board found that music appreciation students scored 63 points higher on the verbal and 44 points higher on the mathematics sections of the Scholastic Achievement Test (CEEB, 2001). According to a recent poll, schools with music programs have a 90.2% graduation rate while schools without music programs have a 72.9% graduation rate. In addition, schools with music programs have a 93.3%

attendance rate as compared with an 84.9% attendance rate at schools without music programs (Harris Poll, 2006).

### **Classical Music in General**

Classical music is often presented in a generalized non-specific manner, meant to represent all forms of music that involve vocals, orchestral, or instrumental virtuoso selections. In reality, classical music is one form of historical western music used to describe a specific genre in which a musical style prevailed or in which a particular composer produced their works. The major styles of western music are normally segmented into the categories of: the Medieval period (476A.D. to 1400A.D.), the Renaissance period (1400A.D.-1600A.D.), the Baroque period, (1600A.D.-1760A.D.), the Classical period, (1730A.D.-1820 A.D.), the Romantic period, (1815 A.D.-1910 A.D.), and the 20th century musical period (1900-1999). Major composers of the classical period are Ludwig van Beethoven, Franz Joseph Haydn, and Wolfgang Amadeus Mozart. To further understand the relationship of Mozart's music to cognitive development it is necessary to view the history of western music, the development of Mozart's style of composition, and his place within western music. While Mozart is often used within research exploring the Trion Theory, a section on composer Dmitri Shostakovich is included as one of his compositions will be used to explore the effects of the Cognitive Arousal Theory.

### **The Medieval Period (476A.D.-1400A.D.)**

The Medieval Period (476A.D.-1400A.D.) is described as the beginning of written notation, harmony, and counterpoint. Prior to this time, music was either played

or sung as a solitary melody with no accompaniment. As Europe emerged from the Dark Ages, the Catholic Church gained power. The first type of approved church music was a style known as chant or Gregorian Chant which involved singing a solitary melody individually or as a group singing the melody in unison. The importance of medieval music grew as its use became popular in both sacred and secular settings. Within the churches, medieval music evolved from one octave keyboard organ style melodies to multiple keyboard and multiple octave pipe organs. Around 1000A.D., organum style developed, in which singers performed melodies in octaves or in which composers experimented with songs where the melodies were performed in harmonic intervals of fourths and fifths (above the melody line). Musical notation or written music developed by Guido d'Arezzo, enabled the placement of notes for later performance (Lloyd, 1968).

With the continued experimentation of organum, additional melodies were added to chant style music resulting in the first form of counterpoint. Continued progression eventually led to methods of articulating and illustrating counterpoint, allowing for styles of the descant and motet which are supplementary melodies and words added to the organum style (Lloyd, 1968).

### **The Renaissance Period (1400A.D.-1600A.D.)**

The word renaissance (rebirth) refers to the rise in learning, humanism, and reverence for the church as expressed in the arts. Renaissance musicians sought to restore a classical form of antiquity based upon past artistic and philosophical standards. Toward the end of the 15<sup>th</sup> century, period music had gradually matured from two or three part harmony to a four (or more) part counterpoint. Music continued to incorporate more free flowing and smoother textures, utilizing imitative parts and melody lines. With



the invention of the printing press, published music began to circulate, replacing handwritten manuscripts.

The music of the renaissance period, often described as homogeneous, imitative and polyphonic, appeared in both secular and sacred forms. Secular music was performed in the form of madrigals (or vocal ensembles) and instrumental forms. The sacred music of the period, performed in churches and other religious settings consisted mainly of motets and masses. The lute appeared as the predominant instrument of the period for secular and celebratory performances, while the organ continued to dominate the sacred forms (Lloyd, 1968).

### **The Baroque Period, (1600A.D.-1760A.D.)**

The term Baroque, a French derivative of the Portuguese term barroco, (which describes an irregularly shaped pearl), was used to describe an irregularity of style, applied more to art than music. The particular characteristics of Baroque music incorporate an early use of the basso continuo (figured bass or a bass line with harmony composed above it), or in another form where musical emotion was portrayed as happiness (with major keys and a fast tempo), sadness (with minor keys and a slower tempo), and anger (demonstrated with harsh sounds and discordant harmonies). Major composers of the period include: Claudio Monteverdi, Alessandro Scarlatti, Henry Purcell, Antonio Vivaldi, George Friderich Handel, and Johann Sebastian Bach. In 1607, Monteverdi's first opera appeared in Italy. Concertos (or solo works with instrumental accompaniment) by Vivaldi prevailed as Scarlatti's harpsichord compositions projected the instrument into mainstream performance. Many operas and oratorios (vocal drama derived from sacred text), were created by Handel. Johann Sebastian Bach is considered

the master of counterpoint as evidenced by his prolific compositions in the style of the fugue (a multi-voiced form where many entering melodies are accompanied by a contrapuntal theme). Bach composed a large amount of sacred (religious) music as well as keyboard instrumental and vocal (cantata) style pieces. It is reported that one of Bach's musician sons (Johann Christian Bach), became a significant influence on the young Wolfgang Mozart, when the two met in London in the year 1764. It is here that Mozart began his studies with J.C. Bach's counterpoint teacher, Giovanni Martini (Lloyd, 1968).

### **The Classical Period, (1730A.D.-1820 A.D.)**

The term classical music is often incorrectly applied to a style of music which does not include folk or popular music. The specific characteristics of the classical style include a thematic use of orchestral color and variations of tension and release, often performed in large scale productions. The sonata (instrumental music performed in several movements), emerged as a predominant form, utilizing both serious and humorous portrayals. Major composers of the period were Franz Joseph Haydn, Ludwig van Beethoven and Wolfgang Amadeus Mozart. Dances of the period like the gavotte and minuet were often performed instrumentally and accompanied celebrations. As Vienna became the center of European music, many composers sought to study there and compose in the style referred to as Viennese. The development of string ensembles, sonatas and symphonies by Haydn, Beethoven, and Mozart dominate this style and the classical period (Lloyd, 1968).

### **The Romantic Period, (1815A.D.-1910A.D.)**

The Romantic Period succeeded the Classical period with an emphasis on fantasy, imagination and passion. The romanticism of the period lends itself to a looser artistic musical form, occasionally depicted as stories and poetry set to an extended musical performance. In addition, descriptive music based upon texts is introduced, emphasizing religious, political or historical events. The style is often described as dreamy or illustrative and symbolic, and later as portraying a patriotic or nationalistic independence (as in the Russian composers Modest Mussorgsky and Nikolai Rimsky-Korsakov). Additionally, complex period music is presented which features the solo virtuoso performer (especially piano and violin performances). Major composers of the period were Frederic Chopin, Franz Liszt, Niccolo Paganini, Franz Schubert, Felix Mendelssohn, Carl Maria von Weber, and Hector Berlioz. Later romantic composers and masters of the symphony were Johannes Brahms and Pyotr Il'yich Tchaikovsky, with Richard Wagner as the creator of intensely robust operas (Boynick, 1996; Lloyd, 1968).

### **The 20th Century Musical Period (1900-1999)**

The 20th Century Musical Period (1900-1999) saw the rise of composers using non-traditional harmonies and tonal composition. With the continued incorporation of unusual rhythmic structures and melodic composition, period composers such as Mahler, Shostakovich, and Stravinsky experimented with the typical symphony style, building upon the variations of the romantic style while incorporating some traditional structure. Eastern harmonic structure was occasionally incorporated to offer an exotic or exciting flair to the new sounds. Traditionalists such as Rachmaninoff produced major works for the piano in the classical style (Lloyd, 1968).

### **Wolfgang Amadeus Mozart**

Wolfgang Amadeus Mozart (the topic of the “Mozart Effect”) was born in Salzburg, Austria in 1756, the son of violinist and composer Leopold Mozart. Wolfgang Mozart began studying music at the age of four, and by six was writing, composing and performing with his father. During musical tours, Wolfgang Mozart was often touted as the “wonder child”, (Lloyd, 1968, p.341), due to his abilities to sight-read any music, improvise existing compositions, and write entire original compositions from memory. Though Mozart lived thirty five years, he created an impressive amount of compositions. His accomplishments are listed as eighteen operas, one ballet, forty-one symphonies, twenty-six string quartets, twenty-five concertos for one or more pianos, ten instrumental quintets, nineteen piano sonatas, forty-one violin sonatas, forty divertimentos and serenades for various combinations of instruments, six violin concertos, twenty-three sets of dances, and other various concertos for several orchestral solo instruments. In addition he composed forty-two arias, twenty canons, nineteen masses and litanies, and thirty-four songs (Lloyd, 1968).

The titles of Mozart’s works are frequently accompanied with the letter K and a number. This designation corresponds to the catalog of Ludwig von Kochel prepared in 1862, which lists Mozart’s compositions according to the date they were written. It is interesting to note that Mozart was a friend of Joseph Haydn whose prolific number of compositions is likely to have had an effect on his style. During the last ten years of his life, Mozart discovered the music of J.S. Bach (Grout, 2001). It is the contrapuntal style initiated by Bach, later studied by Haydn and interjected into Mozart’s work which contributes to his mathematical style of precision. In traditional counterpoint, “two or more melodies are woven together to make a tightly knit complex musical texture and

musical expressiveness is derived from a dissonant interval followed by a consonant interval, leading from tension to relaxation” (Lloyd, 1968, p.126).

## **Dmitri Shostakovich**

Shostakovich was born in 1906 in Leningrad (St. Petersburg), Russia, and died in 1975. He began studying music at the age of 9, started composing by 11 and wrote his first symphony at age 19 (Lloyd, 1968). Shostakovich was a prolific composer, creating 15 symphonies, eight operas, five ballets, 16 string quartets, 36 film scores, six piano and string concertos, and dozens of other orchestral and choral works (Rijen, 2007). Due to the climate surrounding Shostakovich’s life, he was compelled to compose in the nationalistic style of Soviet Russia, but managed to maintain the post classical influences of Beethoven, in addition to Romantic era composers like Mahler, Stravinski, Rimski-Korsakov, Mussorski, and Hindemith (Fay, 2005).

Shostakovich is described as a passionate composer, incorporating many colorful aspects to his music such as discordant harmonies and intense rhythmic sequences to drive his music (Lloyd, 1968). The fourth movement of his Fifth Symphony (chosen to test the cognitive arousal theory), was used in this study due to the selection’s intense march-like beginning, incorporating the orchestral brass and percussion sections followed by a calm review of earlier melodies concluding with a forceful and dynamic ending.

## **Use of Classical Music to Enhance Cognitive Function**

### **The Trion Theory**

In 1985, Shaw, Silverman, and Pearson proposed the trion model of cognitive function by presenting this theory of neural structure to the National Academy of

Sciences. Experimentation conducted in 1989 led to the conclusion that mental performances of music, chess, and mathematics signal similar precise neural firing patterns. In 1990, the journal *Music Perception* reported that computerized experimentation revealed neural firing patterns which could be linked to specific musical timbres and pitches (Leng, Shaw, & Wright, 1990). An article appearing in the 1991 edition of *Concepts in Neuroscience* reported that music as a 'pre-language' is useful in the future development of advanced cognitive functioning (Leng & Shaw, 1991). Experimentation with a group of college aged students revealed that exposure to a Mozart sonata produced measurably significant but temporary gain in spatial skills, as reported in the journal *Nature* (Rauscher & Shaw, 1993). In 1994, a paper presented at a conference of the American Psychological Association provided evidence of measurable improvement in spatial reasoning of pre-school children (Rauscher, Shaw, Levine, Ky).

Rauscher, Shaw & Ky (1995) reported in the journal *Neuroscience Letters* that music with enhanced complexity produces increases in spatial reasoning. It was presented in the 1997 journal of *Neurological Research* that keyboard instruction in pre-school children produced long-term improvement in spatial-temporal reasoning (Rauscher, Shaw & Levine, 1997). In 1999, the journal *Childhood Research Quarterly* reported that keyboard instruction improved the spatial-temporal abilities of kindergartners (Rauscher & Zupan, 1999). In research conducted at Michigan State University, Tims (1999) advised that adults exposed to keyboard lessons experienced a reduction in stress, accompanied by increases in human growth hormone, (as presented in symposium, Miami, FL, April 23, 1999). Finally, a study presented in the journal *Neurological Research* outlined the success of instruction in proportional

mathematics when accompanied with keyboard instruction (Graziano, Peterson, & Shaw, 1999, as cited by Schmidt, 2006).

Shaw (1985) introduced his trion model of cognitive function based upon the work of Hebb and the Hebb synapse or Hebb Learning Rule, proposed in 1949, along with the work of Mountcastle who first proposed his columnar principle for mammalian cortex in 1978. Shaw offers an example of the Hebb Learning Rule as demonstrated by the classical conditioning of Pavlov's dog (Shaw, 2004).

According to Leonard (2002), Classical conditioning occurs when two unrelated stimuli are provided simultaneously to a subject, whereby the subject begins to associate the two stimuli together and the subject provides an involuntary, reflexive response (elicited behavior) without being mentally aware of why the response is occurring. After a time, the dog, upon hearing the bell, begins to salivate, even though food is withheld from the subject. The dog "learns that the bell sound means food, without the dog undergoing any cognitive processing or thinking about the activity" (p.23).

Mountcastle's columnar research presented the theory that we are born with a highly structured brain, (Shaw 2004) and that the trion model offers an "inherent neural language and grammar we are born with, and that our brains have the innate ability to recognize and manipulate pattern in space and time", (p.30). While the cortical column is composed of 100 neurons, the trion itself has a firing pattern composed of three options, 'above average, average, and below average' (Shaw 2004). Unfortunately, according to Mountcastle, "EEG recording with standard methods has limited utility for specifying the spatial and temporal properties of brain operations during cognitive functions. A major reason is that with classical methods of recording and analysis neither the EEG nor the

MEG can present an exclusive analysis. Any given pattern of surface recorded activity may be produced by more than one distribution of neural activity within the brain” (Mountcastle, 1988, p.10). Mountcastle further indicated that with the use of multiple electrodes (in excess of one hundred) and the introduction of new technologies, more adequate brain imaging can be used to better identify specific areas of neurological activities.

### **Yerkes-Dodson and Cognitive Arousal Theory**

The cognitive arousal theory is based upon the premise that different individuals will perform better at differing levels of arousal, and that individuals will seek their particular level of optimum arousal. The cognitive arousal theory proposes that arousal (the physiological and psychological state of being awake) increases performance up to a maximum point at which time, further arousal impairs performance. This translated to the belief that easy tasks require a high level of arousal for motivation, and that more complex tasks require a low level of arousal for motivation. Put another way, monotonous or repetitive tasks require more effort than complex tasks which are enjoyable. In complex tasks, the performance was seen as curvilinear (inverted U) while in simple tasks, the relationship was linear (Yerkes & Dodson, 1908).

According to cognitive arousal research by Hetland & Weiner (2000) and Nantais & Schellenberg (1999), the arousal theory does not support cognitive improvement in the area of spatial-temporal learning. In a 1999 meta-analysis, Chabris concluded that listening to exciting or enjoyable music may raise spatial-temporal IQ scores by 1-2 points, but that any cognitive improvements were most likely due to the increased attention paid to preferable musical selections. Similar research by McKelvie & Low



(2002) furthered the idea that any changes in spatial-temporal scores from the listeners of Mozart were present only if the participants enjoyed Mozart. Nantais & Schellenberg (1999) took this proposal one step further when the listeners of an audio Stephen King novel raised their spatial-temporal scores, only if they liked Stephen King. Finally, LaFunte (1997) researched the effects of exposing unborn children to music. After the exposure of fetuses to 70 hours of music from 28 weeks through birth, the children experienced developmental superiority in several areas during the first 6 months of birth. In a similar study, Cary (1987) noted more advanced attention and vocalizations with newborn children. McMullen and Saffron (2004) stated that the fluid world of unborn children conduct rhythmic patterns better than musical pitch and harmony. This implies that it is the rhythmic variations that are stimulating the children rather than the complex melodic counterpoint of a Mozart composition (Hamilton, 2005).

### **Spatial-Temporal Animation Reasoning (STAR)**

Shaw (2004) suggested research studies to further prove his indications that exposure to certain musical stimuli can have a positive and measurable effect upon the cognitive development of spatial and temporal abilities. In addition, Shaw introduced a computer program, Spatial-Temporal Animation Reasoning (STAR), which appears to increase spatial and temporal testing scores when combined with music training. The initial studies were formatted in the following manner. A pilot study was implemented in two day care facilities, one with an above average demographic, and one with a below average demographic. All participants were previously tested with the performance subtest of the WPPSI-R. Participants in the above average day care received 15 minutes of keyboard instruction each day. Participants in the below average day care received 30

minutes of group singing each day. At the end of six months, both groups were re-tested with a specific look at the object assembly task and the spatial recognition tasks of the test. As predicted by the experimenters, the combined scores of the day care facilities in the area of spatial-temporal were markedly increased while the scores for the spatial-recognition tasks were unchanged.

Shaw (2004) noted that in a subsequent two year pre-school study, two schools with average demographics were selected and the total number of participants was 78 children. These students were divided into four separate groups. One group received keyboard and singing lessons, one group received only singing lessons, one group received computer lessons and the final group received no special lessons at all. As in the pilot study, the students were pre-tested for spatial reasoning with the WPPSI-R. Also, as in the pilot study, there was a marked improvement in the spatial-temporal task of the keyboard group, with minimum improvements in the other three groups. In the spatial-recognition tasks, there was no difference in the keyboard group with a decrease in the singing group and a slight improvement in the language and no lesson groups. As an additional thought, Shaw's experimenters examined the notion of differences in short term and long term memory with respect to this study. Shaw (2004) indicated that there was 'no significant difference between the children tested one or more days following the last lesson', indicating a long term effect for the enhanced learning.

In a final recommendation, Shaw (2004) stated that the early understanding of proportional concepts is critical for the successful performance in mathematics and science which is currently lacking in present education. Shaw (2004) finished this thought with the following quote, "we predicted that an enhanced ability to evolve

temporal sequences of spatial patterns as a result of music training will lead to an enhanced conceptual mastering of proportional math”, (p.183).

In a subsequent STAR pilot study, Shaw involved 102 second grade children from two separate schools, again using institutions of above and below average demographics. Each group was pre-tested with the performance subtest of the WISC-III to establish a baseline for later comparison. In addition, the researchers added the testing of the students with the Stanford Achievement Test 9<sup>th</sup> edition, to confirm the above and below average performance of the students. The students were separated into three groups. One group received no special computer lessons. The other two groups received either STAR math or commercially available English language computer lessons, delivered in 50 minute sessions twice per week. According to the researchers, the Star math group performed significantly higher (36%) than the English group within the lower demographic school, when tested using a pilot assessment test composed of 25 questions of a pictorial nature.

This led to a main study which was composed initially of 170 second graders from an inner city school, (127 actually participated in the post training testing). In this four month study, the researchers designed the experiment to “explore how piano keyboard training versus an appropriate control, in conjunction with STAR, affected student’s performance in math” (Shaw, 2004, p.194). “As in the pilot study, the students were pre-tested using the object assembly, block design and picture arrangement tasks derived from the WISC-III”, (p.197). Following training, the students were tested using a STAR Evaluation Program, consisting of 44 non-verbal questions. At the conclusion of the 4 month period, “ the piano group scored 15% higher than the control English group

overall on the 44 questions and a striking 27% better on the 16 questions devoted to fractions and proportional math”, (p.197).

Researchers at California’s M.I.N.D. Institute offered several possibilities as to the improvements in the proportional math and spatial reasoning components of this type of testing. First, as children learn and concentrate on the interval (distance) between notes, there is likelihood that they are learning and experiencing spatial relationships. Additionally, as children learn and begin to understand the rhythmic structure of music, they are simultaneously learning fractions, proportions and ratios. Also, instrumental performance stimulates a temporal effect by compelling the child to think ahead (to the next note) while executing the present note and concentrating on the necessary fingerings for both. In other words, pitch, dynamics and note duration will have to be considered in advance while performing in real time. Also, according to Shaw (2002), children further experience a temporal effect by performing a familiar piece of music, thinking and anticipating from memory what will come next.

There have been additional research studies done on the use of music to enhance all sorts of personal achievements, some involving children and learning, and some involving adult learning. In “The Effect of Music Listening on a Computer Programming Task”, (2000), Lesuik conducted a study on the effects of music in reducing stress, thus enhancing a programmer’s performance. The author stated that productivity in the U.S. is lower than other countries and that this may be attributable to workplace stress. The author continued with the thought that music affects mood thereby reducing anxiety, and contributes a “relaxation response” when combined with other stimuli, (p.51). Leusik presented three hypotheses:

The first hypothesis stated that listening to music will not affect the logic error rate of a computer program task. The second hypothesis stated that listening to music will not affect the syntax error rate of a computer program task. The third and final hypothesis stated that listening to music will not affect the anxiety levels of a computer science student.

The experimental subjects were described as 71 undergraduate college students entering a basic programming course. The materials used by the author consisted of the Spielberger State Anxiety Inventory, two instructor developed programming tasks, (locating and correcting both syntax and logic errors in a C programming language), and eleven minutes of music consisting of Brahms Symphony No.1 (3<sup>rd</sup> movement), and a portion of Respighi's Pines of Rome. In addition, the author included alternate musical selections and a four-point Likert scale measuring the enjoyment of the music, (p.52).

The author's research design consisted of a control, primer, and periodic group. The control group received no music prior to or during their programming task, the primer group received the eleven minutes of music prior to beginning the programming task, and the periodic group received the eleven minutes of music prior to the task and periodic music during the actual programming task. ANOVA comparisons between the groups were conducted via SPSS.

The results of the study found that there were statistically significant differences in anxiety levels between the control and music groups following the initial eleven minutes of music listening, which the author indicates rejects the 3<sup>rd</sup> hypothesis. In addition, the periodic music group experienced less anxiety than the primer group. In a comparison of the logic and syntax error corrections, the author indicates that there were

no statistically significant group differences between the three groups, but that the periodic group scored best in both areas. The author closed with suggestions for expansion of this study with more control of artifacts such as the ethnicity and diversity of the students, choices of musical selections, and the notion that anxiety reduction in programming might produce more user friendly software.

Shortcomings of the study included the numerical disparity between male (58) and female (14) students, the relatively low number of students in the study (72), and ethnic disparities. Strengths included the application of exposure to music on a complex task, the programming correction exercise, and the potential for anxiety reduction in both the workplace and the classroom.

In the article, *The Mozart Effect and Primary School Children*, authors Ivanov and Geake, (2003) conducted research along the lines of the original Rauscher and Shaw study which purports that merely listening to specific selections of classical music will enhance the cognitive performance of upper primary school children. In this example, children were exposed to either no music or selections consisting of the initial Mozart piece and an alternate selection by Bach, and then subjected to a paper folding task. The task consisted of visualizing how a folded piece of paper with a hole, would look unfolded. This spatial-temporal task was conducted untimed, with the majority of subjects finishing the task within 10 minutes. In addition, these researchers included a 'prior exposure to music' questionnaire. As a preliminary premise to this study, the researchers indicated four concerns regarding the Mozart Effect:

1. Controversy regarding the effect appears to be born out of a general belief that exposure to classical music enhances basic intelligence.

2. Are the necessary components of the musical selections which cause the effect found in only one of Mozart's compositions, all of his selections, or other composer's works?
3. Personal and demographic differences in the research subjects might yield different results.
4. Teachers may not be interested in the actual causes and components of the effect, just the nature of whether the effect is temporary, permanent, or to which subject it best applies (Ivanov & Geake, 2003).

The study subjects consisted of 76 5<sup>th</sup> and 6<sup>th</sup> graders (42 girls and 34 boys) from one Australian primary school. The group was divided into three sections, one receiving no music (only background noise, one receiving the Mozart sonata, and one receiving the Bach selection (Toccatina in G major BWV916). The Mozart group listened to the entire selection for 30 minutes. The Bach group listened to the toccata repeated four times, equaling a 30 minute exposure. The musical selections were played for the students both during instructions and during the test. The prior musical experience questionnaire was administered before the classical music exposure and the paper folding test.

The results of the testing indicated that both the Mozart and Bach groups scored significantly higher on the paper folding test than the control (background noise) group, with the Mozart group scoring modestly higher than the Bach group. In addition, both the prior musical training questionnaire results and the differences in sex and age of the subjects did not appear to offer a significant variance when compared with the task test results, (p.410). The authors indicated that this may have been the first study to test student's cognitive abilities in their 'natural' setting. Though the study group was small in nature, it did address several components of previous works in an effort to both

promote areas of further study and identify artifacts such as the cognitive arousal theory, alternate composer effects, natural background noise in the control group rather than silence, and prior musical exposure.

In Rote-Learning and the Mozart Effect, Jackson and Tlauka (2004) reviewed the components and concepts of the initial studies, including the premise by Leng and Shaw that exposure to complex forms of music resulted in a firing of neural cortical patterns necessary for spatial-temporal cognitive reasoning. This is also known as the 'trion' model. After noting the inconsistent attempts by past researchers to fully replicate or improve upon the initial studies, the authors proceeded in the direction that it is necessary for the effect to be reproducible in both lab and real world or natural environments. The intent was for this study to use the initial Mozart piece (K448) and a piece by Philip Glass (Music with Changing Parts), initially identified by the original researchers as inferior in producing the Mozart effect.

As a methodology, 32 first-year psychology students "13 male and 19 female aged between 18 and 56 years, mean=28 years of age", (p.213). Study participants used computerized simulated maze patterns containing 15 rooms, and headphones which played the musical selections. The Mozart and Glass selections were played immediately prior to the maze challenge, and the students were tested following each selection no less than one and no more than 7 days apart.

When the students' results were compared, there appeared to be no significant difference in the maze performance times following either musical selection. The authors noted that this appeared in conflict with previous studies which denote "performance enhancement with paper and pencil mazes following exposure to the music of Mozart, or



in a rat maze study where rats were able to negotiate mazes faster after hearing the music of Mozart”, (p.218). The authors indicated that there are several possibilities which account for their results. First, they speculated that their computerized measurement tools might have been able to detect smaller differences than previous non-computerized studies, or that their measurement components may not have been able to measure the effect at all.

In concluding, the authors stated that while some may want to put the Mozart Effect to rest entirely, evidence for the effect has been illustrated during independent testing and there is a possibility that researchers have been unable so far to “discover the critical variables affecting the relationship between music perception and spatial reasoning ability”, (p.219).

In a critical look at the study, it appeared that the researchers attempted to cover all necessary components needed to compare this research to past works. For example, both pieces of music from the initial study were used, headphones delivered consistent sound to each participant, the temporary duration of the effect (15 minutes) was considered, and the lab setting provided uniformity to the research. What is different from prior studies was the relatively small sample size, the wide disparity of age of the participants, the lack of a ‘no music’ control group, and the computerized simulation of spatial-temporal learning. It would seem that a general lack of music as enhancing spatial-temporal effect for academic learning was missing from this research design.

### **Learning through the Arts (LTTA)**

A Canadian study entitled Learning Through the Arts: Lessons of Engagement measured effects of attitude and achievement based upon an arts education project.

Smithrim & Uptis (2005) compared the results of a 3-year study involving parents, teachers and 6000 students. In this research, a “learning through the arts’ (LTTA) program was initiated (including surveys and testing ) and introduced into multiple schools with grades 1 and 4 in year one, grades 2 and 5 added the second year, and grades 3 and 6 added in the third year”, (p.112). The research include both a quantitative and qualitative components which included standardized testing for quantitative results (in both language and mathematics) and open ended questions and interviews for the qualitative component. Non-LTTA schools were used as controls.

The Learning through the Arts Program (LTTA) is a partnership between teachers and arts educators which supports the professional development and collaborative learning of both curriculum and instructors. There are several examples of curricular topics within the LTTA structure. These are described as: history through role playing, multiplication through songwriting, mathematics and geometry through visual arts, social studies lesson plans through storytelling and in-role writing, science lessons through dance, history through documentary photography and video, structures and mechanisms through building scale models, and language arts lessons through global percussion.

In the results of the LTTA study, the authors indicated that exposure to the arts did not appear to adversely affect performance on traditional school subjects and that mathematics scores in particular showed a statistically significant improvement, including a long term effect. The authors further indicated that students at the LTTA schools appeared to be ‘highly engaged’ while at school, and that this could be the cause for general improvement. In addition, though some students indicated a general dislike for arts activities, it appears that the combination of some peer conformity and varied arts

experiences contributed to the feelings of interest and engagement. The authors concluded that their exploration of the literature contributed to further questions such as the relationship of mathematics and music, or movement and reading. Further research is needed to either “dispute the effects of student engagement and the arts, or to explore the relationship between the two” (Smithrim & Uptis 2005, p.124).

### **The Mozart Effect**

Recent educational literature has reported that the exposure of individuals to classical music may have some influence upon subsequent cognitive testing where spatial and temporal abilities are measured. In addition, research has indicated (with some conflicting results) that the exposure of children to classical music prior to testing, has produced measurable improvements in scores for a temporary duration, and that continued music instruction can lead to an increase in the special and temporal reasoning skills of elementary age children. The phenomena, cited as the Mozart Effect, commenced with the introduction of an article appearing in a 1993 edition of Nature Magazine, entitled Music and Spatial Task Performance. In this report, an experiment was conducted using an abstract reasoning test derived from a Stanford- Binet intelligence scale. The methodology consisted of three groups of 36 college students, each exposed to a different pre-test condition. One condition consisted of 10 minutes of silence, the second group listened to a 10 minute relaxation tape, and the third group listened to 10 minutes of Mozart’s sonata for two pianos in D Major, (K448). After translating the results into IQ scores, the outcome indicated two effects. First, the group that listened to the Mozart selection scored 8 to 9 points higher on the IQ scale than the other two conditions (119 for Mozart, 111 for relaxation, and 110 for silence), and the

effect was reported to be temporary, on the order of 10-15 minutes (Rauscher, Shaw, & Ky, 1993).

In addition to the aural exposure or lack of it, the authors included a check of the subjects' pulse in an effort to eliminate any arousal aspects of the exposure. In a check of the results, the authors conducted a one factor (listening condition) ANOVA which indicated " $F_{2,35}=7.08, p=.002$  and that pulse rate checks conducted before and after the listening condition by two factor (listening condition and time pulse taken) ANOVA indicated no reaction or main effect for pulse, excluding arousal as a factor in the final scores" (Rauscher et al, 1993). As a first study, the authors stated that areas of future study should include more research into the effect of a re-testing delay period, the degree of musical complexity necessary to illustrate the effect, and a comparison of musicians to non-musicians.

As material grew from the initial study, research intensified with regard to theoretical aspects of musical training, educational responsibility, increased performance in science and mathematics, and the relationship of brain functioning to the development of more abstract cognitive skills or spatial and temporal reasoning.

The Mozart Effect is described as a measurable connection between music and mathematics using human cognition to stimulate the spatial and temporal areas of the brain (Shaw, 2004). Shaw stated that, "music and mathematics are causally linked through the built-in, innate ability of the brain to recognize symmetries and use them to see how patterns develop in space and time", (p.186). Shaw asserted that there is a difference between spatial-temporal math reasoning and language-analytic math reasoning especially with regard to the notion that music and spatial-temporal math are

connected on a cognitive level. This concept presupposes that the traditional language-analytic approach to education neglects the mental visualization necessary to succeed in conceptual mathematics described by Shaw as mental imaging or thinking in pictures.

Shaw (2004) further indicated that autistic learners are not capable of traditional learning in a language-analytic environment, but excel in technology and science due to their spatial-temporal coping skills necessary for learning. In a meta-analysis by Hetland and Winner (2002) the authors prepared a quantitative compilation of ten meta-analytic research studies which were designed to illustrate Cognitive Transfer from Arts Education to Non-Arts Outcomes: Research and Policy Implications. As a summary, the following inferences were drawn from a synthesis of the article which dealt with Classroom Drama and Verbal Skills, Music Listening and Spatial Reasoning, and Music Learning and Spatial Reasoning.

### **Classroom Drama and Verbal Skills**

Classroom drama is described as integrating acting into class curriculum. According to Hetland and Winner (2002), previous researchers “Kardish and Wright (1986) found “positive relationships between drama and reading, oral language development, self-esteem, moral reasoning, and various drama skills”. Conrad (1992) later used Kardish and Wright’s model and ascertained that a positive effect was noted in the areas of “verbal achievement, self-concept, and creativity”, (p.12).

Podlozny (2000) researched eighty studies comparing classroom drama on academic achievement and divided the results into “seven distinct verbal outcomes testing instructional qualities by enactment, plot and leader”, (p.13). These outcomes are described as “oral recall, written recall, reading achievement, reading readiness, oral

language development, vocabulary, and writing skills”, (p.15). Podlozny indicated that “classroom drama was found to have a positive effect on six of the seven verbal outcomes, with written story recall having the most significant effect”, (p.15). Only the category of vocabulary proved an inconsistent category due to the low level of statistical significance ( $p < .24$ ), (p.16). Of particular interest to the researcher is Podlozny’s statement that “what is remarkable is not that drama’s strongest effects are direct ones, rather that drama does have the power to foster skills that then transfer to new material”, (p.17).

### **Music Listening and Spatial Reasoning**

According to Hetland and Winner (2002), Hetland (2000a) “identified 36 relevant experiments involving 2,469 subjects who included listening to a music stimulus predicted to enhance spatial reasoning”, (p.19). The authors indicated that there were many variations of the original Rauscher and Shaw study which included the original Mozart composition (K448), works by other classical period composers, contemporary works, and total silence. In addition, several testing instruments were used in the subsequent studies, some not totally appropriate in the measurement of spatial and temporal enhancements. For example, the authors found that the Stanford-Binet 4<sup>th</sup> ed. Paper Folding and Cutting subtest to be appropriate for the measurement of spatial and temporal ability, but that the Stanford-Binet Pattern Analysis or Matrices using pattern logic tests do not “qualify as measuring spatial and temporal abilities”, (pp. 19-20).

In addition, the wide variation of music samples used in several of these studies is seen as adversely affecting the conditions present during the experiments. Initially, the authors indicated that the difference in “music versus silence and to a lesser degree,

music versus relaxation is indicative of the arousal theory which stated that unless over stimulated, music enhances spatial performance because it arouses”, (p.21). Later, they noted that the differences in the arousal and silence studies are not significant. The authors identified that in their first analysis of the 36 experiments “music’s influence is specific to spatial-temporal, rather than to all types of spatial measures, thus leading to evidence against the arousal theory”, (p. 22).

While the second analysis conducted on the experiments which directly measured spatial-temporal yielded a significant relationship, the authors indicated that there are two concerns which appear to affect the conclusion. First, (concerning lab procedure), the authors stated that “experiments with stronger research designs had higher average effects, and second, the authors indicated that a mechanism directly linking the effect could not be identified”, (p.23). The authors theorized that prior music instruction, subject’s mood or musical preference may have affected the outcome. As a conclusion to this segment, the authors indicated that while there is evidence that “a relationship does exist between musical and spatial reasoning and that the areas of the brain which process this information are not entirely independent, there is uncertainty as to whether the connection is because the processing areas are nearby or overlapping”, (p.24). The authors point out that further research is necessary with tighter controls in research design and to look at potential “cognitive mechanisms such as Shaw’s trion or Parson’s rhythm model”, (p.24).

### **Music Learning and Spatial Reasoning**

Hetland (2000b) identified 19 studies in which children who were exposed to at least 2 years of music instruction were compared to those that had not received prior

music instruction. According to the authors, the studies involved “singing, playing musical games, learning musical notations, improvising or composing music, moving responsively to music, including clapping and playing instruments”, (p. 26). The experiments were divided into three groups for analysis; “spatial-temporal, nonspatial-temporal, and spatial tasks which could not be clearly distinguished as spatial-temporal” (p.26).

In the authors’ first analysis of 15 studies (701 subjects), the spatial-temporal test consisted of the “Object Assembly subtest from the Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R) or Wechsler Intelligence Scale for Children, (WISC-111) and the Spatial-Temporal Animation Reasoning (STAR) program developed by Matthew Peterson of the M.I.N.D. Institute located at the University of California, Irvine. Results indicated that students with music training scored higher, though keyboard instruction proved no better than any of the other methods. In addition, “results were higher with individual rather than group lessons, studies where children learned standard musical notation, and studies in children under six years of age”, (p. 27-28).

In the second analysis (of 5 studies of 694 subjects) using Raven’s Matrices (a test of observation and clear, logical thinking), the results “provide support for the claim that the effect of music instruction is specific to spatial-temporal and not non-verbal tasks generally”, (p. 29). In the third analysis (of 9 studies of 655 subjects), a look at the effects of music instruction outside spatial-temporal which included spatial reasoning is presented. Using the “Children’s Embedded Figure Test, Bead Memory from Stanford-Binet, and multiple subtests from WPPSI-R”, the authors discovered that though the test scores were lower than the spatial-temporal group, the effect was still significant. It is



from this that the authors concluded that “music instruction may not be limited to spatial-temporal tasks but may enhance spatial reasoning more broadly”, (p. 29).

In closing, the authors stated that, “there is a solid, generalizable finding that, for children aged 3-12, active instruction in music, (not listening alone, although listening is a component of such instruction), enhanced performance on a specific type of spatial task classified as spatial-temporal”, (p. 30). The authors concluded with the statement that the applicability of music and the enhancement of spatial-temporal reasoning to the educational system, lies within research which determines exactly what type of musical instructional components enhance this effect. This includes a closer look at student populations, backgrounds, ages, and length of musical instruction. In addition, a look at whether spatial reasoning through musical instruction enhances the real world academic successes of children or whether current instruction emphasizes a spatial approach to learning” (p.31), and exactly where the multi-dimensional skills attained through an improvement in spatial reasoning would appear in contemporary curriculum.

In an article written to describe the introduction of the Mozart Effect as a scientific legend, Bangerter and Heath (2004) proposed the idea that while the effect was not well received academically, the media perpetuated its success. The author’s explanation of this effect was proposed as three life-cycle phases described as, emergence, growth, and decline. Emergence was listed as a first report of a finding where the information is accurate and where most scientific articles end. Growth was described as the interest in a scientific topic generated outside scientific circles, where the information is reconstructed for a general understanding by non-scientists. Decline was described as the erosion of general interest, or when the listening public has become

oversaturated with information. The findings of the three studies conducted by the authors indicated that the Mozart Effect elicited more interest than reports of similar topics and that this interest persisted for a longer period of time. The effect was discussed more often in states where the quality of primary education was more problematic, and that the Mozart Effect mutated over time which included the adaptations necessary to perpetuate local interest.

According to Hetland (2000), attempts to replicate the initial findings failed due to a lack of a statistical significance. This led to speculation as to whether initial experimental designs were properly replicated especially with regard to subject ages, intelligence, prior musical ability or training, and the measurement of spatial ability itself. Hetland (2000) indicated that the initial researchers (Shaw & Rauscher, 1993) conducted their own review and determined that based upon the trion model, researchers must limit the measurement of the student's ability to perceive mental imagery when no physical model is present (Shaw, 2004).

In the duel of competing Mozart Effect philosophies, an article by Jausovec and Habe (2003) attempted to isolate the location of brain changes and stimulation using EEG measures of power and coherence. In a summary of their findings, it appeared that an audio clip of Mozart's K448 elicited a "higher desynchronization of the lower-1 alpha band", (p.5). According to the authors, this indicated that the music of Mozart influenced "attention, alertness, and expectancy", over the audio clips of Haydn and Brahms, (p.5), which translated to an increase in arousal, supporting the arousal theory over the trion theory.

## **Conclusion**

This review of the literature furthers the belief that continued research is necessary to determine the cognitive means by which the Mozart effect manifests itself. In the cases of the triion or cognitive arousal models, neither explanation seems definitive. The studies presented in the literature lend themselves to the presence of multiple artifacts outside the scope of the initial research designs. For example, diverse experimental techniques and variations on presentations yielded varied results. In the cases of Shaw's triion or Nantais & Schellenberg's cognitive arousal explanations, the experiments which sought to show the relationships of certain music to learning, were not about learning at all, but rather about how the brain processes spatial-temporal stimuli, and music in general. While there are studies which do show an increase in spatial-temporal abilities for varying periods, it is not yet possible to generalize to specific age groups or offer any reliable recommendations for the playing of classical music to a select audience for a specific end result. Hodges (as cited by Fernandez, 2006) stated at a recent presentation conducted at the University of Miami, that music in itself does not make us smarter, but rather that the brain uses music to increase interconnections much the same way that knowledge exercises the brain. Also, Hodges declared that music appears to make us smarter because it helps us understand ourselves as human beings and our relationship to the world (Fernandez, 2006).

In terms of mandates for Florida standardized testing and Federal educational directives, it would be beneficial for both teachers and educational administrators to collaborate in an effort to determine the beneficial effects of such testing as compared to the elimination of fine arts programs. This literature review indicates that there is a body

of research which emphasizes that the unrelated educational effects of an arts curriculum can be translated into measurable gains within a diverse assembly of students, including the positive effects of personal development (Fitzpatrick, 2006; Carlson, Hoffman, Gray, & Thompson, 2005; Hodges & O'Connell, 2005; Chamorro-Premuzic & Furnham, 2004; Eng, 2004; Haley, 2001; Matthews, 2001; Whitehead, 2001; Kluball, 2000; Lesuik, 2000; Neuharth, 2000; Cheek, 1999; Gardiner, 1996; Trent, 1996).

Quality research should further examine the educational by-products of music and art in schools, to ascertain if there are beneficial manifestations of student and social behaviors favorable to the school environment, (including performance on non arts relates subjects). Colwell (1992) wrote that music educators have begun to stress non-musical outcomes to education such as “self-discipline, positive self-concept, experiential learning, and the ability for competitive and cooperative learning without constant grading” (p.196). Arts research does not lend itself specifically to laboratory study, further intensifying the issues common with social sciences research. Attention paid to appropriate and replicable experimental structure, can enhance and further arts research in both the qualitative and quantitative designs. Finally, the comparisons between arts and non-arts related subjects need to be examined to see if viable transitory links between topics can be established or whether arts magnets as entry points for students correlate positively with performance in traditional academic subjects.

## CHAPTER III

### RESEARCH METHODOLOGY

#### **Purpose of the Study**

The purpose of this study was to explore the measurable cognitive benefits of exposing primary school aged children to classical music as measured by the Naglieri Nonverbal Ability Test (NNAT) (Harcourt Assessment, 1996). Previous researchers claimed that exposing students to certain types of classical music enhanced cognitive abilities for a measurable duration. Improvement in the spatial-temporal skills of students can lead to a greater understanding and increased performance of higher forms of mathematics and engineering, which require a mental visualization for the solution to problems (Foley, 2006; Palmer, 2001; Cheek & Smith, 1999). The ultimate goal of this study was to determine if listening to differing classical music can improve the thinking abilities of children, and whether these enhanced abilities can translate to measurable cognitive gains.

The research methodology was developed to address the research questions and examine the hypothesis as they relate to cognitive improvement. The research methodology consisted of a quantitative examination of the measurable spatial-temporal cognitive gains achieved through exposure to certain types of classical music. The sections of this chapter include the research design, population, sampling plan, setting, instrumentation, data collection procedures, ethical aspects for data collection, and analysis of the data. This chapter concludes with an evaluation of the research methodology.

## **Hypothesis**

This study investigated whether there is measurable cognitive improvement among second through fifth graders following an exposure to classical music of varying types or silence. In addition, this project investigated the differences in personal/structural factors (age, gender, grade level, past musical training, and enjoyment of the music), as they related to the students' cognitive performance. Based upon these considerations, the principal investigator hypothesized the following:

- 1) Second through fifth grade students who are exposed to the music of Mozart will experience greater improvement in cognitive performance than students exposed to Shostakovich or silence. ( $\alpha = .05$ )
- 2) The differences in personal/structural factors (demographic, academic, and music experience) will affect the cognitive performance of second through fifth grade students that are exposed to classical music or silence. ( $\alpha = .05$ )

## **Research Questions**

Based upon the previous hypothesis, the following research questions were developed:

- 1) Will there be a difference in the students' performance on the NNAT between the groups which experienced Mozart and the groups which experienced Shostakovich or silence?
- 2) Based upon the personal structural factors, will there be differences in the student's performance on the NNAT, when provided with a specific classical musical experience?

3) Based upon the personal structural factors, will there be differences in the student's performance on the NNAT, when exposed to silence?

### **Research Design**

The researcher chose the NNAT as a pre-test and post-test measure following a differing post-test musical experience or silence. The research was of a Static Group Comparison Design (for the post test group) as the class groups remained intact while randomly assigned to the three treatments (Campbell & Stanley, 1963). The research was quasi-experimental in nature, therefore true randomization could not be achieved with intact class groups (Campbell, & Stanley, 1966). The subjects were tested in their natural environment (Douglas and Bilkey, 2007) with the differences in NNAT scores collected at one point in time. The study was comprised of a convenient sample. The classes were randomly assigned to the treatment groups, therefore the students were not individually selected at random.

The researcher also chose a personal/structural factors survey for the measurement of age, gender, grade level, past musical training, and enjoyment of the music. Previous studies continued to provide limited personal descriptors of their participants (e.g., age, race, gender, handedness, and socioeconomic status), which may influence intelligence test scores (Bangerter & Heath, 2004). One previous study had included the prior musical training and personal descriptors of their participants, (music classes within school or private music lessons) or satisfaction with the music during testing (Cassity, Henley & Markley, 2006).

Many previous Mozart Effect studies contained faulty research procedures. The introduction of an independent control group had not been used in several past studies

(Hughes, 2001; Rideout, Steele, Bass, & Crook, 1999; Steele, Brown, & Stoecker, 1999; Dougherty, & Werner, 1998; Rideout & Taylor, 1997; Rauscher, Shaw, & Ky, 1993), and thereby did not allow a comparison of scores between listening to Mozart and merely attempting the spatial problems. Excluding the studies conducted by Steele, Ball, & Runk (1997), the Stanford-Binet spatial subtest (paper folding and cutting questions) had been (with one exception), the only spatial measure used within Mozart Effect research. Using one test limited the understanding of the Mozart Effect to the results depicted with only one measure of spatial intelligence (Jones, 2003). There are multiple strengths within this research design. A quantitative design will have a higher internal validity than a qualitative analysis. The design included a pre-test and post-test instead of a post-test only. A small test environment equaled greater stability and uniformity during testing. Data collection included personal information, music preference and prior music training. All subjects were members of a heterogeneous group, which were chosen at random by class groups. All subjects received the same cognitive pre-test and post-test.

Limitations of the research design were that the testing device had not been used previously to measure the Mozart Effect. There was a relatively small sample size and the group contained limited socioeconomic diversity. The subject population was comprised of pupils from one school which precluded the results from being generalized beyond this grouping of students. The results obtained cannot be generalized to subjects beyond conceptual mathematics, and the study was of a relatively short duration.

### **Dependent Variables**

The main dependent variable was depicted as a change in spatial-temporal intelligence as reported by the overall score achieved on the NNAT test of non-verbal



intelligence (post-test score minus the pre-test score). In this study, the subcomponents of the NNAT were also measured as dependent variables. The post-test minus the pre-test was compared in the four subject areas of; Pattern Completion (PC), Reasoning by Analogy (RA), Serial Reasoning (SR), and Spatial Visualization (SV) (Stinnett & Trevisan, 1996).

### **Independent Variables**

The independent variables were defined as the types of classical music exposure or silence during standardized post testing. During post testing, some groups heard a musical selection of Mozart and some heard a musical selection of Shostakovich. The groups that did not hear any classical music, experienced silence prior to the NNAT post-test.

### **Attribute Variables**

The attribute variables were the personal/structural factors prior to testing. The theoretical definition of baseline musical ability has been considered previously (Hassler, Birbaumer, & Feil, 1985, 1987), but has not directly been examined in studies before 2004 (Jones, 2003). This included prior extracurricular music lessons used to control for any effect of previous music training. In studies done after 2004, demographic information, handedness, and the presence of neurological, psychological, or learning disorders were obtained for the purpose of examining cognitive changes resulting from music exposure (Crncec, Wilson, & Prior, 2006). This study proposed to address the operational definition in a personal/structural factors survey capturing demographics, music experience and music satisfaction.

## **Population and Sampling Plan**

### **Participants**

The participants were all 2<sup>nd</sup> through 5<sup>th</sup> graders from one Southeast Florida private school. The majority of students came from families of moderately high to high socioeconomic status (SES). The pre/post test and personal/structural survey was group administered according to class and was presently limited to the entire population of approximately 200 students. Data was collected from the children during the post-test phase.

The experimenter presented the NNAT to all students selected for this study on the first meeting. Following a 14 week period, the researcher met again with the students. On the second meeting, the students experienced a Mozart or Shostakovich selection of similar duration, or a period of silence. At the conclusion of the musical experience or silence, the students were asked to fill out a short personal/structural factors survey, and complete the NNAT post-test.

This quasi-experimental study used a sample of convenience and the mortality from either the experimental or control groups could not be anticipated. The targeted population was selected primarily due to successes with prior research designs and the inherent limitations of the proposed testing device. According to previous attempts at replicating the initial study, selected students were chosen from only one grade level or from university students when the initial researchers (Rauscher et al, 1983) conducted the first reported experiment.

The sampling plan included the entire accessible population of 2<sup>nd</sup> through 5<sup>th</sup> graders, which were invited to participate in the study. The final data producing sample

consisted of those from the accessible population who completed both parts of the study. The research plan included a random treatment assignment at each class level of all eligible students. The students were tested as a group within their respective classes, comprising a total number of twelve separate class groups within the selected four grade levels.

### **Instruments**

The Naglieri Non-Verbal Ability Test (NNAT) is a cognitive testing instrument used to measure non-verbal intelligence. The test is an individual or group-administered measure of school ability designed for children, with versions comprising kindergarten through the twelfth grade. It is composed of four sections of 38 narrow scope matrix-solution type questions using figural stimuli. An example of an NNAT test item includes shapes organized into groups, where a student must identify a pattern to complete the answer (Naglieri, 2005).

The NNAT is an updated and revised expansion of the MAT (Matrix Analogies Test), which is also a group administered cognitive measure of school ability. The specific components of the instrument are designed to measure performance in the areas of Pattern Completion (PC), Reasoning by Analogy (RA), Serial Reasoning (SR), and Spatial Visualization (SV). The test is uniquely designed in that that the items are not biased for gender, race, or ethnicity, and not subject to differences in socioeconomic or language deficiencies. The NNAT is authored by Jack A. Naglieri and was published in 1996-1997 by Harcourt Brace Educational.

The NNAT was conjointly standardized with the Stanford Achievement Test Series, 9th edition (SAT-9; Harcourt Brace Educational Measurement, 1997) and the

Aprenda, Segunda edición (Aprenda2; Harcourt Brace Educational Measurement, 1998), with a stratified random sampling plan. The Fall norms are based on 22,600 children and the Spring norms are based on 67,000 children. Both samples covered the range of kindergarten - 12th grade. The demographic characteristics (geographic region, socioeconomic status, urbanicity, ethnicity, and private school placement) mirrored the 1993-1994 National Center for Education Statistics (NCES) estimates with an over representation of students from the Midwest region in the Spring Norms (30.2% vs. 23.8%) and some under representation of urban students (5.6% vs. 26.8%) in the Fall sample (as compared to the NCES estimates). Test norming included children with disabilities and those with a limited proficiency in English.

The reliability of the NNAT as measured by the Kuder-Richardson Formula 20 (KR-20) internal consistency reliability estimates are based on raw scores for the total test by age and grade and by grade for the test cluster areas which were calculated during standardization. The total score grade-based internal consistency coefficients ranged from .83 to .93. The age-based KR-20s for total score ranged from .81 to .88. Correlations between levels and adjacent level were at or between .80 to .82. Coefficient alphas will be analyzed for the total scale and each of the subscales of the test (Stinnett & Trevisan, 1976).

There are three types of validity evident within the technical manual. First, some content validity evidence was provided. Second, criterion-related validity evidence was obtained by correlating scores from the NNAT with the Stanford Achievement Test, Ninth Edition (SAT9). Third, limited construct validity data are available in the technical manual (Stinnett & Trevisan, 1976). Factor analysis will be conducted for the NNAT.

The pre and post tests of the NNAT as well as the musical presentations were administered by the researcher. The tests were scored by the researcher and verified by the principal of the lower school. In addition, the students completed a personal/structural factors survey for the purpose of collecting demographic information, prior music experience, and whether the students who experienced Mozart or Shostakovich, enjoyed the musical selection. The survey contains the following elements:

1. Age
2. Gender
3. Grade Level
4. Past musical training
5. Did students like the music

## **Procedures**

### **Ethical Considerations**

In preparation for the study and for authorized participation, the researcher requested that the parent or guardian of each participant sign a parental informed consent form, (see Appendix B) as required by the Lynn University Institutional Review Board (IRB). Furthermore, none of the study participants were personally known to the researcher and the parents/guardians of the participants were informed as to the purpose of the research, the voluntary nature of the study, and that a participant could be withdrawn from the study at any time during the process with no penalty.

For purposes of participant identification, the researcher assigned ordinal numbers to the students so that the NNAT test results and self-reporting questionnaires could be

matched later on for data analysis. The ordinal numbers were assigned from the school's attendance records, and all data sheets and test results are to be kept in a locked file cabinet for the duration of the study.

The testing and data collection associated with this study were completed within one year following IRB approval. At the conclusion of data collection, a termination report was submitted to the Lynn University IRB. All collected data will be maintained in a secure encrypted database or locked file cabinet. All collected data will be destroyed after a period of five years.

### **Data Collection**

Participant protection is a paramount consideration for this research. The components and steps of testing, data collection, analysis of results, and the secure storage of completed materials conforms to the requirements set forward by the Lynn University IRB and the internal policies of the subject private school. Prior to data collection, permission was obtained from the Lynn University IRB as it related to human subject testing. In addition, permission from the subject private school administration, parents, and students was obtained prior to any testing or data collection.

Following the receipt of all necessary permissions, the first phase of testing took place at the subject private school in accordance with their availability in scheduling. In the first phase, students of the selected grades completed the NNAT group administered assessment of non-verbal intelligence. Following a duration of approximately 12 weeks (as recommended by the publisher for a post-test), the randomly selected groups of students received one of two musical experiences or silence, completed the personal/structural factors survey, and completed the NNAT for a second time. The

NNAT pre and post-test results as well as the personal/structural factors survey were collected and coded by class and individual student. This was necessary to record the specific grade level of the student as well as the demographic and descriptive variables for later comparison. Interrater reliability is not an issue within this study, as all of the materials as well as the musical treatments were given by the researcher.

#### Data Collection Procedures

1. Successful presentation of defense proposal
2. Meet with the headmaster of the selected private school in order to obtain permission to conduct research at the selected elementary school,
3. Application submission to the Institutional Review Board, (IRB), (Annex X),
4. Obtain permissions from school, parents, and students for participation through the use of an Informed Consent form which will be sent home with the participating students,
5. Have parents execute an Informed Consent form per IRB requirements, (Annex X),
6. Contact Harcourt Assessment and obtain test materials for the NNAT,
7. Prepare the personal/structural factors survey form,
8. Begin testing and observing student anonymity. Testing is scheduled to begin December 2007 with the first NNAT assessment. Approximately 12 weeks later, the students will hear one of two musical selections or silence.

Following the experience, the students will complete the second NNAT assessment and the personal/structural factors survey. The groups which experience silence will not complete question 6 of the structural/factors survey form, (Did students like the music?). The researcher will coordinate convenient times with the school's staff and

conduct the NNAT assessments, personal/structural factors survey, and musical experiences.

9. Data collection will be completed no longer than one year after IRB approval,
10. Following the collection of data, submit termination report to Lynn IRB,
11. Maintain collected data in locked file cabinet and encrypted computer database,
12. Destroy collected data after 5 years.

### **Data Analysis**

The statistical program SPSS Advanced Models (16.0) was used for data analysis. The first research question, “Will there be a difference in the students’ performance on the NNAT between the groups which experienced Mozart and the groups which experienced Shostakovich or silence”?, was analyzed using MANOVA, with post hoc comparisons for evaluation of the total NNAT score. The individual component scores of the NNAT were analyzed using one-way MANOVA as compared with performance in the subject areas of Pattern Completion (PC), Reasoning by Analogy (RA), Serial Reasoning (SR), and Spatial Visualization (SV). MANOVA was selected in this analysis due to the inclusion of the NNAT subtests as correlated dependent variables. This analysis allowed for the protection of type 1 errors encountered with multiple ANOVAs and the identification of the most important factor (French, Poulson & Yu, 2002).

The second research question, “Based upon the personal structural factors, will there be differences in the student’s performance on the NNAT, when provided with a specific classical musical experience?”, was analyzed using MANOVA to evaluate the comparison of the multiple variables and measures of central tendency (mean, frequency distributions, and variability). For the descriptors of gender and race, chi-square was



used for analysis. Regression analysis was employed to determine the relationships of the independent (explanatory) variables to the dependent variables.

The third question, “Based upon the personal structural factors, will there be no differences in the student’s performance on the NNAT, when exposed to silence?” was analyzed using MANOVA to evaluate the comparison of the multiple variables and measures of central tendency (mean, frequency distributions, and variability). For the descriptors of gender and race, chi-square was used for analysis. Regression analysis was employed to determine the relationships of the independent (explanatory) variables to the dependent variables.

### **Evaluation of Research Methods**

#### **External Validity**

External validity is the degree to which the study’s results can be generalized to other populations (Trochim, 2006). The strengths of this study are that all participants are members of a heterogeneous group, the participants were chosen at random by class grouping, and all participants received the same cognitive pre-post testing device. The weaknesses within this study are that the subject population is composed of students from one south Florida private school and that the study encompassed a relatively short duration. The results cannot be generalized beyond this grouping of students, and cannot be generalized to subjects beyond conceptual mathematics.

#### **Internal Validity**

Internal validity is the strength of obtained results as they are inferred within causal relationships (Trochim, 2006). The strengths of this study are that a quantitative design will have a higher internal validity than a qualitative analysis. There are pre and

post tests conducted rather than a post test only. This particular research took place within a relatively small test environment, which offered greater stability and uniformity during testing. The data collection included personal information, musical preference and prior music training. The weaknesses are that the testing device had not been used previously to measure the Mozart Effect. The participants comprised a relatively small sample size (n=200), and there was limited diversity among the socio-economic status of the tested students.

### **Threats to Validity**

Threats to internal validity are represented by confounding variables, unrepresentative samples, inappropriate statistical testing, and the effects of subjects and experimenters (Graziano & Raulin, 2000). In this study, efforts to reduce errors included a random selection of the 12 tested classes into the three treatment groups by grade. The history and maturation threat of using both a pre-test and post-test following the treatment, are minimized by the relative short duration between the tests (12 weeks). The students were given the same instrumentation and treatments in the same manner. Mortality was addressed by discarding data collected from students who do not complete both the pre-test and post-test.

### **Summary**

The research design, instrumentation, data collection procedures and interpretation of the results allowed the researcher to make comparisons of the collected data and evaluate the results. The students' scores on the NNAT confirmed the hypothesis that exposure to classical music can have a measurable effect on cognitive

performance. The hypothesis of differences in the personal/structural factors survey provided additional insights into the results of the statistical analysis.

## CHAPTER IV

### RESULTS

The initial pre-testing of the students was conducted on December 12-14, 2007. There were a total of 197 students that participated in the first phase of testing. At the publisher's recommendation, a minimum period of 12 weeks was needed between pre-testing and post-testing using the Naglieri Nonverbal Ability Test (NNAT). The post-testing phase was conducted April 7-10, 2008, and the number of students tested during this phase was 180. Due to absences, illnesses, and consent refusals, 168 students participated in both components of the study.

The researcher performed frequency distributions, and no missing data or coding errors were detected. The breakdown of students was as follows. There were 92 male and 76 female students comprising 40 second graders, 43 third graders, 44 fourth graders and 41 fifth graders. In addition, there were 18 seven year olds, 40 eight year olds, 37 nine year olds, 43 ten year olds, and 30 eleven year olds. Also, there were a total of 40 students who indicated that they had taken private music lessons for less than one year, 29 who indicated that they had taken private music lessons for more than one year, and 99 students who indicated that they never had private music lessons.

To illustrate the validity of the NNAT, Cronbach Alpha Coefficients were calculated on both the pre/post test grouped scores and the individual components of the NNAT. Cronbach's Alpha is a measure of internal consistency which indicates whether individual test scores vary with the total score, where a high value indicates that the test is measuring one same thing (Salkind, 2008). While Cronbach's Alpha is not a statistical analysis, it is a measure of coefficient of reliability. A Cronbach's coefficient alpha for

each of these groups and clusters needs to reach 0.7, which is the minimum threshold for the internal consistency reliability in social science research (Nunnally, 1978). The results of the Cronbach Alpha coefficients are depicted in Table 1, which indicated that the pre/post test results of the NNAT as well as the subcomponents (clusters) were within the acceptable range.

TABLE 1

Cronbach Alpha ( $\alpha$ )

Cronbach Alpha Reliability Coefficients for the NNAT

NNAT Components	Coefficient Alphas
Pre-Post Raw NNAT Scores	.847
Pre-Post Normed NNAT Scores	.854
Pre-Post Pattern Completion Scores (PC)	.885
Pre-Post Reasoning by Analogy Scores (RA)	.822
Pre-Post Serial Reasoning Scores (SR)	.768
Pre-Post Spatial Visualization Scores (SV)	.890

According to the author of the Naglieri Nonverbal Achievement Test (NNAT), the NNAT is a group-administered, nonverbal measure of school ability for kindergarteners through high school. The test booklets contain narrow-scope matrix-solution type puzzles which use figural stimuli (Stinnet, 2008). The NNAT itself is a 38 question multiple choice examination which measures non-verbal intelligence. The test contains four individual measures of non-verbal reasoning described as pattern completion (PC), reasoning by analogy (RA), serial reasoning (SR), and spatial visualization (SV). There are several levels of group administration available for varying class grades. For the purposes of this study and according to testing specifications, level C was used for the second graders, level D was used for the third and fourth graders, and level E was used for the fifth graders.

The pre and post testing of the students was completed by class grouping and the post test students were afforded one of two musical experiences or silence as a condition of the treatment. Group A students listened to the Mozart Sonata for Two Pianos K448, used in the initial Mozart Effect Studies as a test the Trion Theory. Group B listened to the Finale of Shostakovich's 5<sup>th</sup> Symphony as a test of the Cognitive Arousal Theory. Group C, (control group) did not hear any music prior to completing the personal structural factors survey and NNAT post-test.

In addition to the use of the NNAT as a pre and post test measure, several demographic items were captured within a personal structural factors survey. These were listed as age, sex, grade in school, whether the students liked the music played for them (for the groups who received a musical exposure), and whether the students had previously participated in private music lessons.

The demographic variables were coded as follows. Group A or treatment group 1 received the exposure to the Mozart double piano concerto. Group B or treatment group 2 received the exposure to the Shostakovich finale. Group C or treatment group 0 did not receive a music treatment. Boys were coded as 1 and girls were coded as 2. Private music lessons were coded as 1=none, 2=less than 1 year, and 3= more than one year. A Likert Scale was used to determine whether the students liked the music and the results were coded as follows: 1 = strongly agree, 2 = agree, 3 = neither agree or disagree, 4 = disagree, 5 = strongly disagree.

The total average across all grades for fall normed scores was 623.70. The total average across all grades for spring normed scores was 637.90. A paired-samples T-test analysis revealed a mean difference of 14.2 points or 2.28%, (pre-test-post-test),

( $t(167) = -6.78, p < .001$ ),  $SD = 27.16$ , thus indicating a minimal probability that the differences between scores is due to chance alone.

The average of the pre-test and post-test norms across all grades and students showed an increase of 2.28%, (calculated by post-test (637.90 minus the pre-test, 623.70). A breakdown of scores by grade indicated that grade 2 had an increase of 5.74% (post-test minus pre-test scores of 619.4 - 601.96). Grade 3 had an increase of 1.34% (post-test minus pre-test scores of 622.12 - 613.8). Grade 4 had an increase of 3.25% (post-test minus pre-test scores of 664.11 - 643.18). Grade 5 had an increase of 0.16% (post-test minus pre-test scores of 644.4 - 634.37).

As indicated previously, each grade level class (2<sup>nd</sup> through 5<sup>th</sup> grades) was divided into three separate groups, receiving three separate treatments. The three groups received a Mozart, Shostakovich, or silence treatment during the post-test phase of testing. Table 2 portrays the overall raw scores, illustrating the results of the NNAT testing for both total raw and normed scores by grade and treatment. Both the raw and normed scores are revealed in Table 2 as the NNAT documentation indicated that it is necessary to convert the raw scores to normed scores in order to make comparisons across grade levels (NNAT, 1997).

TABLE 2

## NNAT Pre/Post Test Scores by Grade and Treatment

GRADE /GROUP		PRE TEST		POST TEST		% CHANGE
<i>n=168</i>	<i>n</i>	RAW	NORMED	RAW	NORMED	
2 Mozart	15	380	9114	406	9276	6.84%
2 Shostakovich	14	347	8474	371	8601	6.91%
2 Silence	11	243	6491	307	6899	26.34%
3 Mozart	14	277	8497	306	8655	10.47%
3 Shostakovich	15	338	9327	358	9409	5.92%
3 Silence	14	291	8569	313	8687	7.56%
4 Mozart	18	512	11835	547	12073	6.84%
4 Shostakovich	13	297	8089	363	8493	22.22%
4 Silence	13	337	8376	382	8655	13.35%
5 Mozart	14	287	8928	295	8970	2.79%
5 Shostakovich	16	293	10039	348	10307	18.77%
5 Silence	11	231	7042	251	7143	8.66%

According to an average of the raw and normed scores, it appeared that while grade 2 experienced a post-test increase of almost 7% for the both the Mozart and Shostakovich groups, the silence group scores increased by just over 26%. For the third graders, the increase in the Mozart group's scores is approximately 10.5%, with an increase of nearly 6 % for the Shostakovich group and an increase of 7.5% for the silence group. The fourth grade group's scores increased almost 7% for the Mozart group, just over 22% for the Shostakovich group and 13% for the silence group. For the fifth graders, the Mozart group's score increased almost 3%, the Shostakovich group increased almost 19% and the silence group increased approximately 8.5%.

From this preliminary analysis, it appeared that the second graders did far better without any musical experiences, the third grade scores improved best following the Mozart experience, and the fourth and fifth grader's scores were significantly higher in the Shostakovich group. Based upon this data, it can be implied that the second graders



were distracted by the music and the third grader's scores improved following Mozart, which was consistent with the initial Mozart Effect studies. The fourth and fifth graders scores improved most following Shostakovich, which is consistent with prior Cognitive Arousal studies.

### Instrument Parameters

In addition to overall scores for the students (pre-test and post-test) depicted in the preceding tables, the subcomponent clusters of the NNAT contains four individual measures of non-verbal reasoning described as pattern completion (PC), reasoning by analogy (RA), serial reasoning (SR), and spatial visualization (SV). The descriptions of the four individual cluster measures are described by the publisher as follows. Pattern completion items required the children to look at a design within a large rectangle from which a portion is missing and determine which response completes the pattern, requiring the child to determine both a general orientation and a spatial orientation. Reasoning by analogy items requires the student to recognize a logical relationship between several geometric shapes while simultaneously working with more than one dimension (shape and shading).

Serial reasoning items incorporate a series of shapes that change both horizontally and vertically. The students must identify both the sequence of the shapes and the changes in the sequence. Spatial visualization items require the student to recognize how two or more designs would look if combined. For example, an item might require that the child decide how an item might look if a circle and triangle were combined in different ways along vertical and horizontal dimensions (Stinnet, 2008, NNAT, 1997).

While each level of the NNAT contained 38 problems, the number of subcomponents varies with differing levels. Level C (second graders) contained 10 PC items, 12 RA items, 11 SR items, and 5 SV items. Level D (third and fourth graders) contained 6 PC items, 10 RA items, 8 SR items, and 14 SV items. Level E (fifth graders) contained 5 PC items, 6 RA items, 8 SR items, and 19 SV items. Correct problem solving in each of these domains (called clusters by the NNAT) were indicative of non-verbal cognitive reasoning.

Table 3 revealed the mean NNAT post-test minus pre-test cluster result percentages by grade level and treatment. The clusters of pattern completion (PC), reasoning by analogy (RA), serial reasoning (SR), and spatial visualization (SV) are represented. From the table it can be interpreted (especially in the area of spatial visualization), all grades improved, with the second graders improving most, (20.94%). This offers support for the initial Mozart Effect study. It should also be noted that the third, fourth and fifth graders improved significantly in the cluster of spatial visualization (SV) following the Shostakovich selection, offering support for the Cognitive Arousal Theory.

TABLE 3

Percentage Increase of NNAT Post-Pre Test Scores by Cluster and Treatment

GRADE/GROUP					
<i>n=168</i>	<i>n</i>	PC	RA	SR	SV
2 Mozart	15	-1.20	8.50	7.72	20.94
2 Shostakovich	14	-6.08	-4.40	21.61	-18.33
2 Silence	11	11.39	19.00	24.69	42.37
3 Mozart	14	9.32	13.62	13.48	2.57
3 Shostakovich	15	-4.06	2.87	7.74	11.63
3 Silence	14	-2.80	2.80	-9.80	29.21
4 Mozart	18	2.00	9.00	-2.42	12.69
4 Shostakovich	13	14.50	7.38	11.62	31.38
4 Silence	13	4.80	9.44	8.18	20.30
5 Mozart	14	3.44	-16.90	7.88	5.66
5 Shostakovich	16	3.94	33.33	18.76	13.61
5 Silence	11	8.13	-3.40	7.53	9.32

The specifics of the cluster findings revealed that for second graders in the Mozart group, there was a decrease in scores of 1% for PC, an increase of 9% for RA, an increase of 8% for SR, and an increase of 21% for SV. For second graders in the Shostakovich group, there was a decrease in scores of 6% for PC, a decrease of 4% for RA, an increase of 22% for SR, and a decrease of 18% for SV. For second graders in the Silence group, there was an increase in scores of 11% for PC, an increase of 19% for RA, an increase of 25% for SR, and an increase of 42% for SV.

For third graders in the Mozart group, there was an increase of 9% in scores for PC, an increase of 14% for RA, an increase of 13% for SR, and an increase of 3% for SV. For third graders in the Shostakovich group, there was a decrease in scores of 4% for PC, an increase of 3% for RA, an increase of 8% for SR, and an increase of 12% for SV. For third graders in the Silence group, there was a decrease in scores of 3% for PC, an increase of 3% for RA, a decrease of 10% for SR, and an increase of 29% for SV.

For fourth graders in the Mozart group, there was an increase of 2% in scores for PC, an increase of 9% for RA, a decrease of 2% for SR, and an increase of 13% for SV. For fourth graders in the Shostakovich group, there was an increase in scores of 15% for PC, an increase of 7% for RA, an increase of 12% for SR, and an increase of 31% for SV. For fourth graders in the Silence group, there was an increase in scores of 5% for PC, an increase of 9% for RA, an increase of 8% for SR, and an increase of 20% for SV.

For fifth graders in the Mozart group, there was an increase of 3% in scores for PC, a decrease of 17% for RA, an increase of 8% for SR, and an increase of 6% for SV. For fifth graders in the Shostakovich group, there was an increase in scores of 4% for PC, an increase of 33% for RA, an increase of 19% for SR, and an increase of 14% for SV. For fifth graders in the Silence group, there was an increase in scores of 8% for PC, a decrease of 3% for RA, an increase of 8% for SR, and an increase of 9% for SV.

From this analysis, it was determined that for second graders, there was a substantial increase in the spatial scores for the Mozart group however; the silence group had the highest increase in spatial scores. For the third graders, there was an increase in the Mozart group's spatial scores, however, the Shostakovich group experienced a higher increase in spatial scores and the silence group had a much higher spatial score than either of the music groups for this grade. For the fourth graders, the Mozart group showed a significant increase in spatial scores, but the Shostakovich group scored much higher, as did the silence group. For the fifth graders, the Mozart group also increased less than either the Shostakovich or silence groups. According to Leng and Shaw (1985), the exposure of college students to the specific musical selection used in this study, yielded a short-term measurable improvement in spatial/temporal performance. This

researcher discovered that the exposure of students (of varying elementary grade levels) to the Mozart Piano Sonata K448, also produced a measurable improvement in the various clusters of the NNAT, specifically the spatial visual cluster. In particular, the second grader's scores improved significantly. Table 4 illustrates the change in cluster scores for the NNAT subcomponents by grade level.

Table 4  
Cluster Scores and Percent Change by Grade Level

NNAT	PC	PC	% Change	RA	RA	% Change
Grade	Pre	Post		Pre	Post	
2	7.82	8.82	12.79	6.18	7.64	23.54
3	5.07	4.93	-2.81	4.86	5.00	2.94
4	5.38	5.62	4.29	5.85	6.46	10.52
5	4.18	4.55	8.71	2.73	2.64	-3.34

PC-pattern completion, pre and post test averages,  
RA-reasoning by analogy, pre and post test averages,

NNAT	SR	SR	% Change	SV	SV	% Change
Grade	Pre	Post		Pre	Post	
2	6.36	8.45	32.86	1.73	3.00	73.71
3	5.57	5.07	-8.98	5.21	7.36	41.10
4	6.85	7.46	8.98	7.85	9.85	25.49
5	4.45	4.91	10.22	9.73	10.73	10.28

SR-serial reasoning, pre and post test averages,  
SV-spatial visualization, pre and post test averages.

As a further analysis, the researcher used a Levene's Test as an appropriate measure for testing the equality of variance for performance on the NNAT. In testing for the homogeneity of variance among groups, the Levene test was chosen in order to test the hypotheses that the variance between groups was equal. In determining the variances, an Independent-Samples T-test was used to compare whether the students' gender levels differed among the four NNAT clusters. The cluster of Pattern Completion (PC) ( $t(166) = .936, p > .05$ ), Reasoning by Analogy (RA) ( $t(166) = .858, p > .05$ ), Serial Reasoning (SR) ( $t(166) = .190, p > .05$ ), Spatial Visualization (SV) ( $t(166) = .164, p > .05$ ), indicated that equal variances were assumed. A Paired-Samples T-test was also conducted to compare the means of the NNAT pre and post testing. The results indicated significant differences in the means of the two groups, (pre-test and post-test), ( $t(167) = 6.78, p > .05$ ).

The nature of this sample necessitated that the researcher perform mean test scores, standard deviations, and variances on the personal structural factor survey items (see Table 5). All participants included in the study were from the same private school and had similar socioeconomic status, variables controlled by the researcher. Upon initial observation, and prior to further inquiry, standard deviations between the five personal/structural factors were non-comparable with the exception of gender, (.499). The variables of past musical training and music appreciation are nominal in nature, and thus could not be initially interpreted at this stage of the investigation.

Table 5

Personal Structural Factors Mean Test Scores, Standard Deviations, and Variances

<b>Domain</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Variance</b>
<i>Population n= 168</i>			
Age	9.16	1.273	1.621
Gender	1.45	.499	.249
Grade Level	3.50	1.102	1.215
Past Musical Training	1.58	.769	.592
Music Appreciation	3.32	1.925	3.704

Similar to the procedures used for the NNAT clusters, the researcher performed another Independent Samples T-test comparing the questionnaire's personal/structural factors, and a Levene test for equality of variances. The T-test revealed that equal variances were found to be assumed for age ( $t(166) = .338, p > .05$ ), grade level ( $t(166) = .854, p > .05$ ), past musical training ( $t(166) = .671, p > .05$ ) and music appreciation ( $t(166) = .356, p > .05$ ). Based on the findings discovered from the Levene t-test, the researcher found no differences among age ( $F = .001, .975$ ), grade level age ( $F = .001(163)$ ), for past musical training ( $F = .387, .535$ ), and for music appreciation ( $F = .408, .524$ ).

Beyond the demographic subcomponents of the personal structural factors survey (age, gender, grade level), the students were asked to indicate their involvement in private music lessons outside of school and whether they liked the musical selection presented to

them. Table 6 illustrates the degree of the children's participation in private music lessons outside of the school.

Table 6

Participation in Private Music Lessons Outside of School

<b>Private Music Lessons</b>	<b>Frequency (n)</b>	<b>Percent</b>
None	99	58.9%
< 1 Year	40	23.8%
> 1 Year	29	17.3%
Total	168	100%

In addition to the measurements of the demographic subcomponents, and participation in private music lessons, the students were presented with a questionnaire to indicate the degree to which they appreciated the musical selection that they heard (Mozart or Shostakovich). Table 7 illustrates the number of children who "liked" the music according the previously mentioned Likert scale. The 49 students comprising the silence group did not hear either of the musical selections and were not afforded an opportunity to answer that question.

Table 7

Degree to Which the Students Liked the Musical Selection

<b>Liked the Music</b>	<b>Frequency (n)</b>	<b>Percent</b>
Strongly Agree	30	17.9%
Agree	49	29.2%
Neither Agree or Disagree	29	17.3%
Disagree	6	3.6%
Strongly Disagree	5	3.0%
Silence Group	49	29.2%
Total	168	100.0%

The 168 participating students were divided into three groups for each of the four grade levels. Each grade level was presented with a treatment prior to the NNAT post-



testing. Table 8 illustrates the number of students who received a Mozart, Shostakovich, or silence treatment.

Table 8

Number of Students by Treatment Intervention

<b>Liked the Music</b>	<b>Frequency (<i>n</i>)</b>	<b>Percent</b>
Mozart	61	36.3%
Shostakovich	58	34.5%
Silence	49	29.2%
Total	168	100.0%

### Main Analysis

The MANOVA (Multivariate Analysis of Variance) was selected as the most effective measure for this study due to the design of this inquiry, and the test's ability to perform analysis on multiple dependent and independent variables, while looking at interactions and contrasts among the variables (Field, 2005). In addition, the MANOVA reduces the chances of type 1 errors encountered when running multiple ANOVAS on multiple dependent variables.

The first research question is: "Will there be a difference in the student's performance on the NNAT between the groups which experienced Mozart and the groups which experienced Shostakovich or silence?" The researcher chose the MANOVA analysis of the three test groups, using the dependent variable of change in the NNAT post-test minus pre-test scores. Unlike ANOVA which is a univariate test, a Multivariate Analysis of Variance (MANOVA) is an analysis which can look at one or more dependent variables, one or more independent variables, and see the contrasts and interactions between groups (Field, 2005).

MANOVA also reduces the chances of type 1 errors encountered when running multiple ANOVAS on multiple dependent variables, and is useful when looking at interval dependent variables (Wendorf, 1997). Considered an appropriate technique when performing multivariate statistical designs, a Factorial MANOVA is used when analyzing multiple nominal independent variables and multiple dependent variables (Wendorf, 1997). Unlike other methods, this approach explored the appropriate differences and led to a reduced chance of performing a type 1 error (Gall & Borg, 2004). The type 1 error did not occur and allowed the researcher to use the entire body of data collected during the research study.

Initially, the dependant variable NNAT clusters of Pattern Completion (PC), Reasoning by Analogy (RA), (Serial Reasoning (SR), and Spatial Visualization (SV) were compared against the independent variable of intervention. The original Mozart Effect study proclaimed that short term exposure of students to the chosen Mozart concerto would enhance at least, spatial-temporal cognitive abilities.

The variables of grade level and intervention appeared to be significant link of cognitive performance ( $t(167) = .270, p < .05$ ). Further NNAT analysis by grade level which compared grade and intervention, revealed that the second grade level proved to be significant, ( $t(167) = .085, p < .05$ ). A comparison of intervention plus second graders was also significant ( $t(167) = .101, p < .05$ ).

The second research question, “Based upon the personal structural factors, will there be differences in the student’s performance on the NNAT, when provided with a specific classical musical experience”, was analyzed using MANOVA and yielded no results of a significant value. The researcher then compared the multiple independent

variables of intervention, grade, age, sex, prior music education and whether the students liked the music. The independent variables of grade level, age, sex, private music lessons, and music appreciation were not significantly related to cognitive performance.

The results of the MANOVA analysis found that for: grade, ( $t(167) = .595, p > .05$ ), age ( $t(167) = .074, p > .05$ ), sex ( $t(167) = .081, p > .05$ ), private music lessons ( $t(167) = .057, p > .05$ ), and music appreciation ( $t(167) = .105, p > .05$ ). Furthermore, in a comparison of both post-test minus pre-test raw and scaled scores, the independent variables of private music lessons and music appreciation were found to be correlated at the  $<.05$  level, with raw scores ( $t(167) = 2.24, p < .05$ ), and scaled scores, ( $t(167) = 2.36, p < .05$ ). In addition, the independent variables of private music lessons and music appreciation, age and sex were also found to be correlated ( $t(167) = 5.86, p < .05$ ) (raw), and ( $t(167) = 4.10, p < .05$ ) (scaled).

The third research question, “Based upon the personal structural factors, will there be no differences in the student’s performance on the NNAT when exposed to silence”, was analyzed using MANOVA and also yielded no results of a significant value. The results of this MANOVA analysis found that for: grade, ( $t(42) = .100, p > .05$ ), age ( $t(42) = .081, p > .05$ ), sex ( $t(42) = .043, p > .05$ ), private music lessons ( $t(42) = .039, p > .05$ ), and music appreciation ( $t(42) = .039, p > .05$ ).

## Research Questions

### Research Question One

The first question asked if there would be differences in the student’s performance on the NNAT based upon the musical intervention experienced, (Mozart, Shostakovich, or silence). From the comparison of raw and scaled cumulative scores (combining all of NNAT clusters), it appeared that second graders showed increases of 7% for both musical

treatments, (Mozart and Shostakovich), and 26% for silence. Third graders showed an increase of 10% for the Mozart group, with a 6% to 7% increase for the Shostakovich group and silence group. The fourth graders increased 7% for the Mozart group, 22% for the Shostakovich group, and 13% for the silence group. The fifth graders increased their scores 3% for the Mozart group, 19% for the Shostakovich group and 8% for the silence group.

A comparison of these scores suggests that the second graders were distracted by the music and performed better following a period of silence. The third graders performed better following the Mozart piano sonata. The fourth and fifth graders performed far better following the Shostakovich selection. Thus, evidence supporting the Trion Theory (and the Mozart Effect) was seen only in the third graders, following the chosen musical selection. The effect of Cognitive Arousal was seen in the fourth and fifth graders. Additionally, the MANOVA was conducted on each specific grade level revealed that only the second graders experienced a significance between their grade level and the musical intervention.

#### Research Question Two

The second research question asked if based upon the personal structural factors, will there will there be differences in the student's performance on the NNAT when provided with a specific classical musical experience. Following the MANOVA analysis of the variables grade level, age, gender, private music lessons, and music appreciation, the results appeared non-significant and thus, unrelated. As a matter of interest, a test of between subject effects, yielded a correlation for the domains of private music lessons and music appreciation, ( $<.039$  for raw scores post-test minus pre-test,  $<.030$  for scaled

scores post-test minus pre-test. Also, private music lessons, music appreciation, age and sex were additionally correlated at .018 raw and .046 scaled, (post-test minus pre-test).

### Research Question Three

The third research question asked if based upon the personal structural factors, will there be no differences in the student's performance on the NNAT when exposed to silence, additionally yielded no results of a significant value. This further indicated that the independent variables represented in the personal structural factors survey were non-significant and therefore unrelated. Also provided as a matter of interest, a test of between subject effects, yielded a correlation for the domain of silence and grade  $p = <.01$ .

## CHAPTER V

### SUMMARY OF FINDINGS

The purpose of this study was to explore the potential measurable enhancements to cognitive intelligence, achieved through the short-term exposure of elementary aged students to classical music. The existing body of research found within the literature suggested two things. The first research segment questioned whether small amounts of music can have a measurable effect on the spatial/temporal cognitive intelligence of the listener (Shaw, 2004). The second research segment proposed that long-term music training (especially keyboard instruction), can have a positive effect on the traditional academic areas of study (Cheek, 1999). In addition to these inquiries, there are selected researchers who purport that listening to certain music (especially exciting or personally preferable music), will cognitively arouse an individual to the point that they will perform better on a test of intelligence (Nantais and Schellenberg, 1999).

This particular study explored the measurable improvements in cognitive intelligence (especially spatial/temporal intelligence) through the short-term exposure of elementary students to classical music. In addition to the testing of the Mozart Effect, a second group of children were exposed to another musical selection, in an effort to measure the effects of the Cognitive Arousal Theory. A third group of children experienced only silence as a control prior to post testing.

The researcher chose the Naglieri Nonverbal Abilities Test (NNAT) as a pre-test and post-test measure of cognitive intelligence, due to the test's ability to measure nonverbal performance across four cluster areas. These clusters are defined as: pattern completion (PC), serial reasoning (SR), reasoning by analogy (RA), and spatial-temporal

(ST). The NNAT was selected as a competent measure of these areas, as the test items are portrayed as multiple choice matrix-type problems, which are not dependent on fluency in English. In addition to the NNAT, the researcher introduced a personal/structural factors survey during post-testing in order to measure other factors which could have an influence on testing outcomes. The ultimate goal of this study was to ascertain if a short-term exposure of classical music to elementary grade students would cause measurable gains in spatial/temporal cognitive intelligence. Furthermore, this investigative research explored the variables included in the personal/structural factor survey items, and the corresponding scores that were impacted by the intervention of classical music type or silence.

#### Review

According to the initial Mozart Effect studies, the exposure of students to classical music (specifically Mozart's Sonata for Two Pianos in D Major, K. 448), produced spatial/temporal cognitive gains as measured by a Stanford-Binet paper folding and cutting exercise (Leng & Shaw (1985). Much of this research has been challenged by subsequent investigators, who have been unable to replicate the effect. As an alternative, Cognitive Arousal Theory was proposed by successive researchers as an explanation of short-term cognitive gains (Hetland & Weiner, 2000). Utilizing the NNAT in this study allowed the researcher to test the Mozart Effect or Trion Theory of neural alignment (Mountcastle, 1978), and the Cognitive Arousal Theory in which increased arousal equates to better performance (Nantais & Schellenberg, 1999) as explanatory vehicles of these short-term cognitive gains. Finally, a silence (control) group was included along with the two musical treatment groups.

The impact of age, grade, gender, past musical training, and music appreciation were included within the personal/structural factors survey, to measure their impacts on the post-test NNAT results. This section was incorporated into the design, as previous investigations implied that personal and demographic differences in research subjects might offer varying results during Mozart Effect testing (Ivanov & Geake, 2003).

The researcher initially hypothesized that second through fifth grade students who are exposed to the music of Mozart will experience a greater improvement in cognitive performance than students exposed to Shostakovich or silence. ( $\alpha = .05$ ). The researcher also hypothesized that personal/structural factors (demographic, academic, and music experience) would have a relationship to cognitive performance in the students that are exposed to classical music. ( $\alpha = .05$ ).

#### General Findings

Based upon a comparison of pre-test and post-test scores, the researcher discovered that there were changes in the student's scores on the NNAT depending upon the treatment received, and that the variation in scores differed across the four grade levels. The researcher found that across all four grades, the student's experienced a modest increase in scores, which included all three treatment groups. This in itself is not indicative of significant gains as the post-test NNAT comprised the same material as the pre-test, which included two additional weeks between testing, (the publisher's recommendation is a minimum of 12 weeks between tests for the group administered instrument).

In a comparison of average pre-test-and post-test normed scores by treatment, the second graders improved their scores modestly for both the Mozart and Shostakovich



groups but experienced a significant improvement in the silence group. This indicated that while there is improvement in both of the music groups, the students at this grade level may have been distracted by the musical selections and performed much better after an equal period of silence. The third graders scored highest in the Mozart group, but also showed moderate increases in both the Shostakovich and silence groups.

The fourth and fifth graders showed slight improvements in the Mozart and silence groups but scored highest in the Shostakovich groups, indicating that the students were aroused by the Shostakovich selection. In looking at improvements in scores among the three treatment groups, the researcher found that the second graders were distracted by the music, but that the third grader's scores improved following Mozart, (offering support for the Mozart Effect and Trion theory). The fourth and fifth graders improved best following Shostakovich, indicating support for the Cognitive Arousal Theory.

#### Cluster Findings

In addition to the improvement in normed scores across the four grades and treatment, the NNAT is composed of the previously mentioned four clusters of non-verbal reasoning. These are listed as pattern completion (PC), reasoning by analogy (RA), serial reasoning (SR), and spatial visualization (SV). Pattern completion items required the children to look at a design within a large rectangle in which a portion is missing, and choose which response completes the pattern, requiring the child to determine both a general orientation and a spatial orientation. Reasoning by analogy items required the students to recognize a logical relationship between several geometric shapes while simultaneously working with more than one dimension (shape and shading).

Serial reasoning items incorporated a series of shapes that change both horizontally and vertically. The students must identify both the sequence of the shapes and the changes in the sequence. Spatial visualization items required the students to recognize how two or more designs would look if combined. For example, an item might require that the child decide how an item might look if a circle and triangle were combined in different ways along vertical and horizontal dimensions (Stinnet, 2008, NNAT, 1997).

The researcher found that for the second graders in the Mozart group, there was a slight decrease in scores measuring patterns. There were slight increases in scores for geometric shape recognition, and a marked increase in the spatial ability scores. For the Shostakovich group, the second graders experienced decreases in pattern recognition, geometric relationships, and spatial abilities, but had a substantial increase in shape recognition. For second graders in the Silence group, there were increases in all clusters, with a significant increase in spatial scores.

For third graders in the Mozart group, there were modest increases in all clusters, with a minimal increase in the spatial scores. For third graders in the Shostakovich group, there was a decrease in pattern recognition scores and moderate increases in the geometric relationship scores, and spatial scores. For third graders in the Silence group, there was a decrease in the pattern recognition and geometric relationship scores, and a large increase in scores for the spatial scores.

For fourth graders in the Mozart group, there were modest increases in their pattern recognition and geometric shape relationship scores, with a higher increase in the spatial scores. For fourth graders in the Shostakovich group, there were increases in all

clusters with a significant increase in their spatial scores. For fourth graders in the Silence group, there were increases in all clusters with a higher increase in spatial scores.

For fifth graders in the Mozart group, there were small increases in all clusters with the exception of a decrease in geometric shape relationships. For fifth graders in the Shostakovich group, there were increases in all cluster scores, with a marked decrease in reasoning by analogy. For fifth graders in the Silence group, there were increases in all of the clusters with a substantial increase in geometric shape relationships.

From this analysis of the student's spatial scores, it appeared that for second graders, there was a substantial increase in the spatial scores for the Mozart group but the silence group had twice the increase in spatial scores. For the third graders, there was an increase in the Mozart group's spatial scores, however, the Shostakovich group experienced a higher increase in spatial scores and the silence group's spatial scores were more than twice as high as the Shostakovich group. For the fourth graders, the Mozart group showed a significant increase in spatial scores but the Shostakovich group scored much higher, as did the silence group. For the fifth graders, the Mozart group's spatial scores also increased less than either the Shostakovich or silence groups, with the Shostakovich group scores proving to be the highest.

Based on these post-test outcomes, the researcher found that the spatial scores of the Mozart groups increased across all four grade levels by an average of ten percent, which is consistent with the proposals set forth in Shaw's (2004) Mozart Effect. The researcher also discovered that the spatial scores of the third, fourth, and fifth grade Shostakovich groups increased by an average of nineteen percent, supporting the tenets of the Cognitive Arousal Theory proposed by Hetland & Weiner (2000). Only the

second grade Shostakovich group exhibited an eighteen percent decrease in their spatial scores. The silence or control groups averaged a twenty five percent increase in spatial scores across the four grades.

#### Theoretical Considerations

According to Leng and Shaw (1985), the exposure of college students to the specific musical selection used in this study, yielded a short-term measurable improvement in spatial/temporal performance. This researcher discovered that the exposure of students (of varying elementary grade levels) to the Mozart's Sonata for Two Pianos in D major, K. 448, also produced a measurable improvement in the various clusters of the NNAT, specifically the spatial visual cluster.

The Yerkes-Dodson Law or Cognitive Arousal Theory is based upon the premise that different individuals perform better at differing levels of arousal, and that individuals will seek their particular level of optimum arousal, (Yerkes & Dodson, 1908). The Law itself stated that arousal (the physiological and psychological state of being awake) increases performance up to a maximum point at which time, further arousal impairs performance. The work of Hetland & Weiner (2000) indicated that cognitive arousal theory does not support spatial learning. In agreement, Chabris (1999) stated that any increase in spatial scores after listening to music, resulted from the participant's enjoyment of the music and not from an increase in cognitive intelligence.

In this study, the researcher found that after presenting the students with the Shostakovich selection, measurable gains were observed within different clusters of the NNAT. This portion of the investigation revealed that with the exception of the second graders, the balance of the grade levels who heard a musical selection, experienced

higher increases in their spatial scores following Shostakovich. This data supported past findings regarding the exposure of subjects to arousing music followed by a measurable cognitive spatial improvement (Nantais & Schellenberg, 1999). As stated previously, the second graders appear to have been distracted or over stimulated by the Shostakovich selection.

The personal/structural/survey items of age, gender, school grade, private music lessons and music appreciation were compared against both the post-test minus pre-test normed NNAT scores, and the post-test minus pre-test performance on the individual clusters of the NNAT. There were no variables within this group that were observed to have an effect on the final scores.

#### Conclusions

This research project provided information which is relative to the field of music education and academic performance. There is evidence that the exposure of the students to both of the classical music treatments increased cognitive scores in differing clusters for a temporary period which was not measured beyond the post-testing phase of the study. The results indicated that there is no clear conclusion as to which treatment proved to be the most successful across multiple grade levels. The only statistically significant factor produced by the study revealed that the second grader's scores were most affected by the type of treatment they received.

Past studies coupled with the results of this investigation, indicated that there is evidence supporting classical music exposure and enhanced cognitive measures of intelligence. Putting aside the results of the initial Mozart Effect studies on spatial-temporal intelligence, prior inquiries have proposed everything from musical exposure

enhancing mathematics (Haley, 2001) to increased elementary reading skills (Carlson, Gray, & Thompson, 2004) as well as personal and social development (Chamorro-Premuzic & Furnham, 2004).

The unintended consequences of arts education have been well documented within the literature, leading to a belief that a reduction in music education in favor of mandated standardized testing can hinder the very thing that the state and federal government tests are attempting to measure (Hetland & Winner, 2002; Johnson & Edelson, 2003; Kardish & Wright, 1986; and Podlozny, 2000). Issues such as the demand for increased classroom space, time for mandated test preparation, and the allocation of scarce resources, have left the public schools in a position where arts education programs are being eliminated.

#### Limitations

There are several limitations to this study. First, the relatively small number of tested students at one location does not allow the generalization beyond this population. Secondly, due to the nature and enrollment of the private school, all of the tested students came from an upper middle class to upper class socioeconomic group. Additionally, the duration of the study was relatively short (14 weeks). Finally, the study did not include culture or ethnicity within the personal/structural factors survey.

The NNAT testing instrument was group-administered according to class size and all students eligible were invited to participate. This quasi-experimental cluster study utilized a sample of convenience and the mortality from either the experimental or control groups could not be anticipated. The NNAT functioned as a competent measure

of non-verbal intelligence in this study, but has never been used previously in this type of research design.

While the researcher personally conducted all aspects of testing and treatment and attempted to control the similarity of the pre and post testing conditions, the unpredictable nature of a fully functioning educational institution precluded the exact duplication of the pre and post testing environments. An additional limitation of this study was the prior in-school music education programs. The school had employed several different music teachers over the years, and the prior level of music instruction may have varied considerably among the four grades.

#### Recommendations for Future Research

Future research is needed in this area due to the variations in data among the four grade levels and the three treatment groups. There is considerable past research which has indicated that arts education (especially music education) can be beneficial at this age level, but that arts education has incorporated more than mere listening (Hetland, 2000). Many of the longer term studies included several months of keyboard training into the question of whether there are significant unintended outcomes of music education. Some studies have simply proposed that music students are higher academic achievers and others proclaim that higher achieving students gravitate toward music classes in school (Haanstra, 2000; Hines, 2000; and Trent, 1996).

In attempts to replicate the initial Mozart Effect study, prior studies investigated the results of left handed individuals to ascertain if cortical firing patterns in either hemisphere of the brain were affected by the music of Mozart. While sample sizes have been small, researchers indicated that larger samples coupled with a variety of music can

be useful in learning whether different composers can also provoke a result (Bauman & Coutu, 2000). Gender trends can continue to be explored with regard to arts education as some studies have indicated that girls are drawn more to arts experiences than boys (Uptis & Smithrim, 2003). Issues of engagement were also noted as contributors to successful arts programs which can in turn contribute to unrelated academic topics (Spohn, 2008). Measuring the engagement factor of arts education students can be useful in determining the level of student involvement and the corresponding achievements in other subjects.

Further research using the concepts of language-analytic instruction versus spatial/temporal learning can be compared across a variety of arts education programs. Student performance on cognitive measurements other than the NNAT can be used in schools with variations in arts education programs to learn which arts programs are beneficial in traditional academic topics (Grandin, Peterson, & Shaw, 1998).

Recommendations for future research might also include a similar research design looking at the results of NNAT testing across multiple schools of similar enrollment. Factors such as a comparison of mainstream schools, magnet schools, parental involvement in music or performance, and larger sample sizes should yield additional data. The design of this particular study could be expanded to include a comparison of both short term music exposure and longer term instrumental instruction to ascertain if either or both combined will offer more a definitive insight regarding the questions proposed by this project.

There is a contemporary trend within schools and cultural institutions or businesses to engage in partnerships to further arts education within schools, and to



investigate the benefits of arts education through research projects. In the quest to differentiate learning through the arts from learning the arts themselves, schools and partnership elements need to establish programs which can transcend limited grant funds (Colley, 2008).

There is evidence within the literature that some music educators feel a disconnect between the music teacher and the student learner. Future trends in the quest to learn whether music education enhances academic learning and social skills needs to include an agreement between the teachers and learners as to what is seen as personally relevant for the student (Westerlund, 2008).

#### Implications for Practice

This research investigation re-emphasized the issue of arts education reductions within public schools. Due to the increased demands placed upon Florida schools to perform on standardized tests such as the FCAT and the SAT (Rosenthal, 2007), compliance with NCLB guidelines (Winn, 2006), the allocation of scarce resources (Weiss, 2006), and class size reduction mandates (Borkowski & Sneed, 2006), arts education programs are being squeezed out of the mainstream curriculum (Conrad, 2006; Eisner & Day, 2004). There is a growing concern within scholarly literature that the elimination of these programs, especially music education classes will detract from traditional subjects due to the unintended consequences achieved from the students' exposure to these programs (Fitzpatrick, 2006; O'Connell, 2005; Eng 2004; Hetland & Winner, 2002; Lesuik, 2000).

Theorists such as Carlson, Hoffman, Gray, and Thompson (2005); Olson (2003); Kemmerer (2003); Haley (2001); Whitehead (2001); Kluball (2000); Neuharth (2000);

Gardiner (1996); and Trent (1996), have proposed and offered examples of musical enrichment programs and their relation to cognitive achievement. Continued research by Shaw, Campbell, and Gardner, though their approaches may differ, indicate that music is an important component of learning, not only useful in learning mathematics or improving reading skills, but an integral element of personal growth ultimately leading to maximum academic achievement. Just as our country's Founding Fathers determined that a public education available to all children was a necessary component of civilized society (Alexander, 2001), their followers realized that music education and the exposure of children to various forms of western music, was a necessary ingredient of a well rounded education (Sperry, 1973).

The connection between music education and cognitive improvement in public schools has been shown to be of substantial importance (Carter, 2006; Elpus, 2007; Fitzpatrick, 2006; Foley, 2006; Hanna, 2007; Hanson, 2003; Hodges, 2000; Johnson & Edelson, 2003; Johnson & Memmott, 2006; Petress, 2005; Stewart, 2007). Researchers have also shown that there is considerable information currently available regarding arts education and its effect on academic performance and personal growth. A successful contextual understanding of music education and cognitive improvement is an important step in the enhancement of student learning (Campbell, 2002). Appropriate academic learning and the socialization of students will ultimately enable schools to deliver superior instructional services to their students, thereby enhancing education and service to the community at large (Chamorro-Premuzic & Furnham, 2004). Learning through arts programs have also cited improvements in unrelated aspects of specific musical instruction by reducing absenteeism, gender differentiation, enhanced student

engagement, facilitating individual expression, and increases in the enhancement of hands-on learning (Uptis & Smithrim, 2003). Mathematics education has been shown to be enhanced through the use of rhythmic instruments and an analysis of symphonic orchestra structure by allowing children to experience and play differing instruments (Edelson & Johnson, 2003). Elective keyboard training in one school for a period of six months, produced measurable improvements in spatial-temporal reasoning, deemed necessary for higher mathematics (geometry), proportional reasoning, and engineering (Grandin, Temple, Peterson, & Shaw, 1998). Finally, researchers have agreed that exposing children to music does not detract from performance in the traditional academic subjects, and that the proliferation of music in world society equates the subject to language as a basic and specific human characteristic (Demorest & Morrison, 2000).

Arts education programs (including music programs), are presently at risk in public schools due to state and federal testing requirements which have directly impacted local funding issues and curricular direction (Conrad, 2006). Present trends in testing and class size reduction, have affected the amount of time and space available for subjects deemed “enrichment programs” (Eisner & Day, 2004). The unintended positive consequences of arts education are a concern in the reduction or elimination of music education programs which researchers have indicated influence both academic performance and personal development (Hetland & Winner, 2002; Hodges & O’Connell, 2005).

### Final Thoughts

At the beginning of this process, the researcher made the distinction between the more traditional methods of language-analytic instruction which includes a lecture type

of environment where information and solutions are quantitative in nature (Shaw, 2004), and spatial- temporal learning which involves thinking mentally in advance about a problem's solution, much like chess (Schmidt, 2006; Grandin, Peterson, & Shaw, 1999) . Prior research has suggested that language-analytic methods neglect the mental imaging necessary to solve proportional mathematics and engineering equations (Shaw, 1999). In contrast, spatial-temporal reasoning, involves looking at sequences and patterns, and the mental rotation of objects in space and time. Researchers Leng and Shaw (1991) stated in their research that even very young students can benefit from a spatial-temporal approach in the area of proportional reasoning. Many contemporary investigations have determined that there are measurable cognitive connections between music education and music exposure, as they relate to the mental visualization necessary to understand these types of problems (Foley, 2006; Palmer, 2001).

Music education in schools continues to be de-emphasized due to scarce resources and the belief that music is of an emotional nature, not subject to academic standards (Reimer, 1999). According to a comparison by the National Standards for Music Education, six out of the nine music education categories have already been measured as improvements in spatial/temporal learning. These categories are listed as singing, instrumental performance, improvisation, composition, reading / notating music, and music listening. The final three categories of evaluating music and performance, understanding the relationships of music to other disciplines, and the relationships of music to history and culture, while also important, are best measured through language-analytic methods (NAME, 2007).

Finally, prior studies have explored and measured the exposure of students to varying styles of classical music or music educational training and offered evidence of measurable cognitive gains. Furthermore, the effects of music on other unintended consequence such as social competencies and personal development should preclude its reduction or elimination, and further promote competent investigation to better understand how the integration of music into present education can benefit both students and teachers.

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**APPENDIX A**  
**PERSONAL STRUCTURAL FACTORS SHEET**

## Personal/Structural Factors Sheet

**Please answer the following questions:**

1. How old are you? \_\_\_\_\_.

2. Are you a boy or girl? \_\_\_\_\_.

3. What grade are you in? \_\_\_\_\_.

4. Have you ever had private music lessons?  |  | .  
\_\_\_\_\_  
(Please check the box)                      No            Yes-Some    Yes-More than 1 year

5. I liked the music that was played for me.  
 |  |  |  | .  
\_\_\_\_\_  
(Please check the box)    Strongly Agree-Agree-Neither Agree or Disagree-Disagree-Strongly Disagree

**APPENDIX B**  
**IRB APPROVAL**



Lynn University

**Principal Investigator:** Michael J. Ader

**Project Title:** Mozart Effect: Exploring the Relationship Between Classical Music and Improvement in the Spatial and Temporal Cognitive Abilities of Elementary School Children

**IRB Project Number:** 2007-033

Application and Protocol for Review of Research Involving Human Subjects of a New Project:  
Request for Exempt Status  Expedited Review  Convened Full-Board

**IRB Action by the Convened Full Board:**

Date of IRB Review of Application and Research Protocol: 11/20/07

IRB Action: Approved  Approved w/provision(s)  Not Approved  Other

Comments:

Consent Required: No  Yes  Not Applicable  Written  Signed

Consent forms must bear the research protocol expiration date of 11/20/08

Application to Continue/Renew is due:

- 1) For a Convened Full-Board Review, two months prior to the due date for renewal
- 2) For an Expedited IRB Review, one month prior to the due date for renewal
- 3) For review of research with exempt status, one month prior to the due date for renewal

Other Comments: Child assent is also required.

Name of IRB Chair: Farideh Farazmand

Signature of IRB Chair  Date: 11/20/07

CC: Dr. Kosnitzky

Institutional Review Board for the Protection of Human Subjects  
Lynn University  
3601 N. Military Trail Boca Raton, Florida 33431

**APPENDIX C**  
**PARENTAL CONSENT**



*Lynn University Institutional Review Board*

*PARENTAL CONSENT FORM*

**THIS DOCUMENT SHALL ONLY BE USED TO PROVIDE AUTHORIZATION  
FOR VOLUNTARY CONSENT**

PROJECT TITLE: Mozart Effect: Exploring the Relationship Between Classical Music and Improvement in the Spatial-Temporal Cognitive Abilities of Elementary School Children

Project number \_\_\_\_\_ Lynn University 3601 N. Military Trail Boca Raton, Florida 33431

We invite your child to participate in a research study conducted at the Sagemont Lower School by Michael Ader, a doctoral candidate at Lynn University located in Boca Raton, Florida. Your child's participation in this study is voluntary. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to allow your child to participate.

**DIRECTIONS FOR THE PARTICIPANT:**

Your child is being asked to participate in my research study. Please read this carefully. This form provides you with information about the study. The Principal Investigator Michael Ader will answer all of your questions. Feel free to ask questions about anything you don't understand before deciding whether or not to allow your child to participate. You are free to ask questions at any time before, during, or after your child's participation in this study. Your child's participation is entirely voluntary and you can refuse to allow your child to participate without penalty or loss of benefits to which your child is otherwise entitled.

**PURPOSE OF THE STUDY**

This study is designed to investigate previous research claims that exposure to classical musical can enhance the spatial-temporal cognitive abilities of children. Unlike the language-analytic or lecture type of learning present in traditional education, spatial-temporal learning involves thinking mentally in advance about a problem's solution, (much like chess), or using the mental visualization necessary to solve proportional mathematics such as geometry or engineering equations.

This study is designed to measure the differences between the pre-and post test results of a non-verbal assessment exercise following hearing a musical selection by composers Mozart or Shostakovich, or an equal period of silence. All children currently attending the 2<sup>nd</sup> through 5<sup>th</sup> grades at Sagemont Lower School will be invited to participate in this research. Your children are selected for this exercise because previous research indicates that these age groups respond best to this type of assessment.

**PROCEDURES**

Before beginning the study and in order for authorized participation, the researcher will request that each parent or guardian of the participants sign an informed consent form. Please understand that participation in this research investigation is voluntary and that there is no penalty if the parent or guardian of the student decides to not allow his or her child to participate during any phase of the study.

## **PROCEDURES CONTINUED**

If you allow your child to volunteer to participate in this study, we would ask your child to do the following things:

The length of this study will be approximately two hours spread over a duration of 12 weeks, depending on the constraints of the school schedule. The study consists of an initial meeting with your children where they will complete a written cognitive assessment exercise. Twelve weeks later, the researcher will meet with your children. At this time, your children will hear a 10 minute musical selection composed by either Mozart or Shostakovich, or experience a 10 minute period of silence.

Following the musical experience or silence, your children will be asked to complete a short four question demographic questionnaire, and complete the same written assessment test as in the first meeting. The questionnaire will ask the student's age, sex, grade, and whether they liked the music that was played for them. This study will be conducted at the Sagemont Lower School, Weston, Florida.

## **DURATION AND LOCATION**

The time necessary for this study pre and post testing, will be approximately two hours. The time will be spread over two separate meetings which will be conducted 12 weeks apart. All components of this study will be conducted in your child's regular classroom with their regular teacher present.

## **POSSIBLE RISKS OR DISCOMFORT**

This study involves minimal risk. The cost of time spent by the lead teacher at each facility helping the researcher, may affect the ability of the lead teacher to present other activities to the participants.

## **POSSIBLE BENEFITS**

While there may be no direct benefit to you or your child by participating in this research, knowledge may be gained which may help benefit our society through an understanding of the importance of arts education programs.

## **FINANCIAL CONSIDERATIONS: NONE**

There is no financial compensation for you or your child's participation in this research. There are no costs to you as a result of participation in this study.

## **CONFIDENTIALITY**

All information collected will be coded by a unique identification number and will be held in a locked file cabinet and kept under lock and key for five years post commencement of the research. Every effort will be made to maintain the confidentiality of the students. Your identity and your child's identity in this study will be treated as confidential. The results of this research study may be published, but your child's name will not be used. All information will be held in strict confidence and may not be disclosed unless required by law or regulation.

## **RIGHT TO WITHDRAW**

You are free to choose whether or not to allow your child to participate in this study. There will be no penalty or loss of benefits to which you are otherwise entitled if you choose not to allow your child to participate.

## **CONTACTS FOR QUESTIONS / ACCESS TO CONSENT FORM**

Any further questions you have about this study or your child's participation in it, either now or any time in the future, will be answered by Michael Ader (Principal Investigator) who may be reached at: [REDACTED], or Dr. Adam Kosnitzky, faculty advisor, who may be reached at: [REDACTED]. For any questions regarding your rights as a research subject, you may call Dr. Farazmand, Chair of the Lynn University Institutional Review Board for the Protection of Human Subjects, at [REDACTED]. If any problems arise as a result of your participation in this study, please call the Principal Investigator Michael Ader, and the faculty advisor Dr. Adam Kosnitzky immediately. A copy of this consent form will be given to you.

**AUTHORIZATION FOR VOLUNTARY CONSENT**

I have read and understand this consent form. I have been given the opportunity to ask questions, and all my questions have been answered to my satisfaction. I have been assured that any future questions that may arise will be answered. I understand that all aspects of this project will be carried out in the strictest of confidence, and in a manner in which my rights and my child's rights as a human subject are protected. I have been informed of the risks and benefits. I have been informed in advance as to what my child's and my task(s) will be and what procedures will be followed.

\_\_\_\_\_  
Parent or Guardian printed name

\_\_\_\_\_  
Parent or Guardian signature

\_\_\_\_\_  
Date

**INVESTIGATOR'S AFFIDAVIT**

I hereby certify that a written explanation of the nature of the above project has been provided to the parent or guardian of the person participating in this project. A copy of the written documentation provided is attached hereto. By consenting to allow voluntary participation in this study, the parent/guardian has represented that he/she is at least 18 years of age, and that he/she does not have a medical problem or language or educational barrier that precludes his/her understanding of my explanation. Therefore, I hereby certify that to the best of my knowledge the person who is signing this consent form clearly understands the nature, demands, benefits, and risks involved in his/her child's participation.

\_\_\_\_\_  
Signature of Investigator

Date of IRB Approval: \_\_\_\_\_



**APPENDIX D**  
**STUDENT ASSENT**



*Lynn University Institutional Review Board*

**Assent of Child to Participate in Research**

**Name of Study:** Mozart Effect: Exploring the Relationship Between Classical Music and Improvement in the Spatial-Temporal Cognitive Abilities of Elementary School Children

**Brief Description of Study:** You are being invited to participate in a research study. The purpose of the study is to see if listening to a classical music selection will improve your score on a written exercise. This research will take place in two sections. For the first section, you will be asked to complete a written exercise. You can refuse to participate in this study at any time.

After a period of approximately 12 weeks, you will complete the second section in which you will be asked to listen to a classical music selection which lasts about 10 minutes or be asked to sit quietly for 10 minutes. After hearing the music or sitting quietly, you will be asked to fill out a short survey which will ask your age, sex, grade in school, whether you take music lessons, and if you heard the music, whether you liked it. After that, you will complete the same written exercise that you did 12 weeks ago. This will complete your participation in the research study.

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