Band on the Brain: Instrumental Music and Student Achievement

ACCEPTANCE

This dissertation, BAND ON THE BRAIN: INSTRUMENTAL MUSIC AND STUDENT ACHIEVEMENT, by EDWARD J. LINDEKUGEL, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Education, in the College of Education, Georgia State University.

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BAND ON THE BRAIN: INSTRUMENTAL MUSIC
AND STUDENT ACHIEVEMENT

by

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ABSTRACT

For the past several decades, non-core programs such as instrumental music instruction have been cut in many schools, largely due to the failure of accountability measures to inform policy makers about the impact of these programs on achievement (Major, 2013). This dissertation addressed this failure by investigating the question, "to what extent does school-based instrumental music instruction impact the learning outcomes of a cohort of high school students in a private Catholic school setting?"

This study compared achievement of students engaged in an instrumental music program versus their non-engaged peers, measured by standardized test means in mathematics and reading. The first stage engaged a stratified propensity score match (PSM) to identify an adequate comparison group, in order to minimize selection bias. The dependent variable was a categorical variable indicating whether or not a student participated in band. The independent variables included gender, ethnicity, standardized test scores, and subject grades. In the second part of the study, groups identified through the PSM are compared using linear regression models utilizing reading and math score means from the SAT-10, and the critical reading and math sections of the PSAT administered in the 2013-2014 academic year.

The participants were approximately 210, 8^{th} – 12^{th} grade students attending a private K-12 Catholic school in the suburbs of Atlanta. The student body is predominantly middle to lower-upper class (75% Caucasian, 12% Hispanic, 6% Asian, 1% African American, and 6% of mixed race) with an approximately equal number of females and males. All students included in the co-hort for research attended the school for at least 5 years. The IBM Statistical Package for the Social Sciences (SPSS) Software was used to conduct the analysis.

INDEX WORDS: Standardized test, Band, Instrumental music, Propensity score match

BAND ON THE BRAIN: INSTRUMENTAL MUSIC AND STUDENT ACHEIVEMENT

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EDWARD LINDEKUGEL

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DEDICATION

This work is dedicated to my wonderful wife, Gina. She was a constant source of encouragement and support to me throughout my entire doctoral program and dissertation process. I could not have accomplished my work without her, and I will be forever grateful for the unwavering support she provided.

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1 INSTRUMENTAL MUSIC AND STUDENT ACHIEVEMENT

Instrumental music has provided many students with an exposure to a variety of learning experiences that can manifest a positive and lasting influence on youth development (Davenport, 2010). However, during the last several decades of education in the United States, there has been a dramatic shift toward an emphasis on standardized test scores in core subject areas such as reading, mathematics, and science. This emphasis on core subjects and standardized tests, as the primary measure of academic success, has had the effect of marginalizing non-core subjects such as physical education, art, chorus, and instrumental music (Armstrong, 2006). This paper challenges the assumption that non-core subjects, particularly music instruction, are less valuable to student achievement. To make this argument several major topics relating to instrumental music instruction in the schools are reviewed including (a) a historical look at the accountability movement, (b) the impact of music on learning, and (c) the relationship between instrumental music and the achievement gap.

Guiding Questions

The major question guiding this study is, “Does school-based instrumental music instruction lead to a statistically significant difference in the learning outcomes for a cohort of high school students in a private Catholic school setting?” The guiding question is broken down into two questions:

1. Does a statistically significant difference in language arts standardized test scores exist between band participants and non-participants?
2. Does a statistically significant difference in math standardized test scores exist between band participants and non-participants?

Review

A Nation at Risk, the 1983 report of the Commission on Education Excellence (Gardner, 1983), was the impetus for a wave of educational reform, focusing on renewed emphasis on education accountability at the federal, state, and local levels (Hansen 1993). A tangible manifestation and continuation of the educational accountability movement was the No Child Left Behind Act of 2001 (NCLB), which was in effect the most recent reauthorization of the Elementary and Secondary Education Act (ESEA) of 1965. Within 4 years of NCLB's implementation what seemed most troubling about No Child Left Behind was that it represented "the culmination of a movement that has been gathering steam in American education for over 80 years" (Williams & Dunn, 2008, p. 177).

The accountability movement in American education had shifted our educational focus toward an emphasis on standards and testing for targeted subjects, it required that schools make incremental Adequate Yearly Progress (AYP) until all students reach the goal of 100 percent proficiency in the main academic subjects (Armstrong, 2006). The most destructive legacy of NCLB may have been that it deflected the dialogue in education away from talking about the education of students and toward a focus on tests, standards and accountability (Armstrong, 2006). NCLB includes mandatory annual testing in the "core subjects" of reading, mathematics and science (Armstrong, 2006), but does not require testing in other subjects like music and the arts. Despite one of its primary goals being the elimination of an achievement gap between white and minority students, that gap has actually increased since NCLB's implementation. In reference to NCLB, "It has neither significantly increased academic performance nor significantly reduced achievement gaps, even as measured by standardized exams. Many schools, particularly those serving low-income students, have become little more than test-preparation programs"

(Guisbond, Neill, & Schaeffer, 2012, p.1). Ignoring and reducing music instruction due to the accountability movement's emphasis on other core areas continues despite the fact that research in the past decade has established significant connections between music instruction and academic achievement (Gadberry, 2010; Hash, 2011; Hollenbeck, 2008; Ruppert, 2006; Salazar, 2012; Southgate & Roscigno, 2009). Music instruction has been shown to be a potential tool in the effort to reduce the achievement gap between various ethnic groups – a problem the United States government has attempted to address (SEDL, 2011).

The United States Department of Education describes the achievement gap as, "the difference in academic performance between different ethnic groups" (SEDL, 2011). When considering this simplistic definition, it may be tempting to reduce the complexity of eliminating the achievement gap to merely mitigating the differences in grade award and testing outcomes between white students and minorities. A closer look at the complex issues surrounding the gap itself may shed light on alternative methods to be used to attack the achievement gap, which places so many American youth in danger of failure to live up to their fullest potential (Thomas, 2011). By repeatedly demonstrating strong connections to academic achievement, particularly in the area of standardized testing, research relating to music instruction has shown that music may be one such method for reducing the achievement gap (Hash, 2011; Kinney, 2008; Salazar, 2012).

How important is music instruction in the 21st century? A 2010 study of workforce readiness revealed growth in employer demand for applied skills such as problem solving, collaboration and creativity (Landrum, Hettich, & Wilner, 2010). Exposure to music brings with it a benefit of fostering the development of these and other similarly critical skills, specifically discipline, collaboration, patience, persistence and motivation (Adderley, Kennedy, & Berz, 2003). Leaders from a number of corporations such as Xerox and Google have expressed the belief that music aids students in the development of workplace relationships, which includes personal flexibility, effective communication, creativity, and innovation (Judson, 2012). Research in music instruction shows a positive relationship to improved cooperation, listening, communication, and the ability to focus on different tasks (Hollenbeck, 2008). Furthermore, it has been found that those students who persist in instrumental music instruction develop greater self-control, have higher self-esteem, and can put forth a greater effort compared to those who dropped out of music instruction (Schmidt, 2005).

According to a recent Harris Poll of 2,286 adults, surveyed online between May 14 and May 19, 2014, many Americans understand the connection between music education and success in the workplace. The poll revealed that 76% percent of Americans identified themselves as having participated in music education in school, with over half of those saying that it was extremely or very important in providing them with the skills of working towards common goals (54%) and striving for individual excellence in a group setting (52%). Also, 71% of the respondents said that music education helps people to be better team players in their careers, 67% say it provides a disciplined approach to solving problems, and 66% said it prepares someone to manage the tasks of their job more successfully (Corso, 2014).

This dissertation will consider several major areas relevant to instrumental music in schools. First, the accountability movement and its effect on educational priorities will be discussed. Second, the impact of music on learning, with specific attention paid to the areas of language arts and mathematics. Finally, the relationship between instrumental music and the achievement gap will be addressed, focusing on the evidence for music instruction's mitigating effect.

The accountability movement and shifting educational priorities.

The current accountability movement in education can be traced back with varying scope and degrees of implementation to the early 1900s (Hansen, 1993). Educational accountability was largely ignored during the 1930s and 1940s, but revived for a short span in the late 1950s (Hansen, 1993). This evolution of accountability continued into the late 1960s marked by the "beginning of mandated accountability in federal programs, while accountability in the 1970s was characterized by applications of systems models and complex technical accounting systems" (Hansen, 1993, p.1). By the 1990s, accountability had increasingly been employed as a tool for educational reform on a national scale (Hansen, 1993). However, the effects of the movement appeared to be fade, as earlier gains were maintained but not built upon (Ledesma, 2012). Despite strong support at the state and federal levels, the accountability movement had largely failed to live up to its expectations (Strauss, 2013).

A major component of the accountability movement is the No Child Left Behind Act (NCLB) of 2001 (Armstrong, 2006). Since its inception, practical implementation of No Child Left Behind Act has been difficult, and it can be argued that its focus on "one-size-fits-all" standardized testing has in some ways undermined other potentially beneficial education reform efforts (Guisbond, Neill, & Schaeffer, 2012). One area of education that has been significantly impacted is instrumental music.

> In an age of increased accountability and educational standardization accompanied by tighter budgets and fewer funds, core subjects, such as mathematics and reading, receive more funding and instructional time in public schools, while non-core subjects, like music, potentially face reductions or elimination in budgets, programs, and staffing. (Major, 2013)

The No Child Left Behind Act of 2001 focused on annual testing in core academic subjects, requiring schools to make incremental Adequate Yearly Progress (AYP) until all students reached the goal of 100 percent proficiency in these main academic subjects by 2014 (Armstrong, 2006). NCLB states that school districts must measure and prove that students make "adequate yearly progress" in core subject areas (Ackley, 2012). Excluding instrumental music from the measured "core" subject list has led to de-emphasis and in some cases elimination of music programs across the country (Major, 2013). Not only did school districts have to prepare students to pass one set of standardized tests, but also they needed to continue to prepare students to achieve higher scores every year.

Indeed, the push for higher test scores has negatively impacted instructional time dedicated to non-core subjects such as band, chorus, and art, as evidenced in Texas, where research within 349 public school districts showed an increase of instructional time for subjects like mathematics, science, and reading in all districts, with corresponding decreases of instructional time for the arts (Heilig, Cole, & Aguilar, 2010). NCLB impairs what art and other non-core classes can do for students by confining students to methods of learning strictly based on traditional subjects (Surber, 2010 p.1). As the United States Department of Education reports:

> Administrators recognize that more time is needed to teach such critical core subjects such as Algebra I. Class schedules are typically changed in order for teachers to have longer blocks of time that allow for instructor-led as well as applied instructional strategies. Administrators recognize the need to change classroom practices to allow students the opportunity to practice skills. (U.S. Department of Education, 2005, p. 3)

The outcome of the need for "more time" committed to "critical core subjects" has often been a reduction of class time for subjects like the performing arts, including band. "As school districts across the nation respond to the challenges of the No Child Left Behind law, children are spending more classroom time on reading and mathematics and as a result some are spending less time on music and art" (Whitehorne, 2006 p.1).

Out of this educational environment, with its emphasis on standardized testing and higher scores in "core" subjects, comes an emerging crisis for the performing arts (Beveridge, 2010). "Some of the short-term effects of this law have troubling implications for subjects that are not evaluated for the purposes of determining adequate yearly progress (AYP), the measure that serves as the basis for all federal funding" (Beveridge, 2010, p.4). One result of the law is that subjects not required for assessment such as band, chorus, and art, have been marginalized. In short, resources and time for these non-tested subjects has declined (Pederson, 2007). According to the Department of Education's report, *Arts Education in Public Elementary and Secondary Schools: 2009-2010*, more than 1.3 million students in elementary school receive no music instruction. The same is true for roughly 800,000 secondary school students (Judson, 2012).

Other factors contributing to the de-emphasis of non-core subjects in schools include the greatest economic decline in United States history since the Great Depression of the 1930s. The decline impacted the nation's economic output and unemployment rate, and just about every classroom in the United States (Hull, 2010). Due to this economic decline, funding for non-tested subjects had often been the first impacted when budgets were cut. The majority of remaining resources had been used to increase instruction for subjects tested for accountability (Pederson 2007; Schneider, 2005). In 2010-2011, one-third of school districts reported that they were considering laying off arts, music, or physical education teachers (Hull, 2010).

Evidence of the effect of the lagging economy specifically on band directors can be found in data relating to salary and job growth. The median salary for high school teachers was $53,230 in May 2010. As of September 2013 it was only slightly higher at $56,000 not even keeping pace with inflation. In a May 2010 report, The U.S. Bureau of Labor Statistics projected that the field will grow only 7% between 2010 and 2020, slower than average (Samaroo, 2013). Signs indicate the situation will not change any time soon (Husch, 2011; New America Foundation, 2014; Oliff, Mai, & Palacios, 2012; Thomasian, 2010).

Regarding this slow growth, the Fall 2011 Fiscal Survey of States showed the continuing compromised financial situation facing states for 2012 and beyond (Husch, 2011). Despite some marginal financial improvements, overall state revenues and spending figures remained below their pre-recession levels, with revenue down over $21 billion, with general fund spending $20 billion below 2008 (Husch, 2011). “The states are facing a protracted budget crisis like none seen in the last 30 years and perhaps not since the Great Depression” (Thomasian, 2010). The National Governors’ Association (NGA) decreed that 2010 was the most difficult challenge for state finance management since the Great Depression (Husch, 2011). “As a new fiscal year begins (FY 2013), the latest state budget estimates continue to show that states’ ability to fund services remains hobbled by slow economic growth” (Oliff et al., 2012 p.1). State budget gaps for fiscal year 2013 total $55 billion in 31 states, smaller than some gaps in recent years, but still historically large (Oliff et al., 2012). Federal, state, and local government each contributes to education funding, with state and local government providing an average of 44% each, demonstrating the relationship between state financial stability and appropriate levels of funding for schools (New America Foundation, 2014).

Indeed, states have cut billions of dollars from education budgets. For example, in Georgia, state legislators and governors cut well over $2 billion in public school funding since 2002 (Shearer, 2014). “The consequences for the arts include everything from the elimination of instrument repair budgets to the loss of entire teaching positions and programs” (Beveridge, 2010, p.5). Further, the requirement for more instructional time committed to “critical core subjects”, particularly for students at the lower end of the achievement gap, frequently results in reduction of class time for subjects like art and the performing arts, including band (Whitehorne, 2006).

NCLB is an overt and recent representation of the environmental shift in education toward accountability and testing in core subjects, negatively impacting music programs around the nation (Major, 2013). This shift has led to a need for educational leaders to justify money spent on school-initiated pursuits falling outside the realm of measured “core” subjects.

Music and academic achievement.

For the last few decades of the 20th, and accelerating significantly in the 21st century, connections have been found between student participation in school instrumental music programs and higher achievement, improved school attendance, increased cognition, and improved attention (Babo, 2004; Olson, 2010; Schellenberg, 2006; Thomas, 2011). Increasingly in the 1990s, studies began to show the positive impact of instrumental music for school-age children. Zanutto (1997) tested several hypotheses relating to student’s involvement with instrumental music programs, concluding that there are significant differences in academic achievement between instrumental and non-instrumental students. Studies of proficiency showed an even stronger correlation between instrumental students and higher scores, specifically in reading and mathematics (McLelland, 2005). Other studies from the period and in the following decades found similar connections to academic achievement (Costa-Giomi, 1999; Gadberry, 2010; Southgate & Roscigno, 2009; Trent, 1996). Specific skills including discipline, collaboration, patience, persistence, and motivation (Adderley et al., 2003) shown to develop through music instruction could be consequentially beneficial when applied to learning in other content areas as well (Olson, 2010). Further skills connected to music instruction include cooperation, teamwork, listening, communication, and multitasking (Hollenbeck, 2008). However, the benefits of music do not end there. Research also suggests music may enhance spatial-temporal reasoning skills (Bugaj & Brenner, 2011; Graziano, Peterson, & Shaw, 1999).

Babo (2004) conducted research on the noted positive relationship between music instruction and achievement, which was an extension of the work by Costa-Giomi (1999), Trent (1996), Zanutto (1997), and others. Factoring in IQ, gender, and Socio-Economic Status (SES), Babo used a series of multiple regression models and concluded that while IQ was the strongest contributor to achievement, a significant relationship does exist between instrumental music participation and academic achievement, with the strongest correlation found in reading/language arts.

There does appear to be tangible differences in the strength of the relationship between music instruction and achievement, that is, it depends on the quality of the music program (Johnson & Memmott, 2006). Students in top quality instrumental programs across the country scored higher in English and mathematics classes than those in low-quality music programs. Standardized testing showed the same types of results, with students involved in any type of instrumental music program, even low-quality programs, than those who were not involved in instrumental music at all (Johnson & Memmott, 2006). Johnson and Memmott’s findings are similar to others who found that music students have significantly higher standardized test scores than non-music students, regardless of social economic status. One such example found low SES 12th graders who were highly involved in the arts nearly closed the achievement gap in reading proficiency between themselves (37.9%) and higher SES peers who were not highly involved in the arts (42.9%) (Catterall, Chapleau, & Iwanaga, 1999). Music supports academic achievement and the relationship between music and academics is statistically strong (Johnson & Memmott, 2006).

One question that is important to address is whether or not the relationship between instrumental music instruction and higher scores is due to the music, or attributable to self-selection of students into music programs (Elpus, 2013; Fitzpatrick, 2006; Hash, 2011; Kinney, 2008). Consistent with the findings of Fitzpatrick (2006) and Elpus (2013), Hash's work indicated that band students tended to be more academically successful than non-band students at the outset of their participation (Hash, 2011). The research indicated that students enrolled in music programs would have scored well on standardized tests whether they were enrolled in music programs or not. (Fitzpatrick, 2006, Hash, 2011, Elpus, 2013).

Despite the recent findings by Elpus (2013) that suggest music students at the onset are high achievers, other studies have shown a possible connection between music instruction and actual increases in intelligence and/or cognition (Andrich, 2012; Blasi & Foley, 2006; Catterall et al., 1999; Fitzpatrick, 2006; Hanna, 2007; Johnson & Memmott, 2006; Petress, 2005; Schellenberg, 2006). Even though music students may be high achievers at the onset the positive effect of music instruction is discernable when one considers time-span. Catterall, Chapleau, & Iwanaga (1999) found that mathematics skills continued to improve for students exposed to music over time. Research, involving 1,476 students of low socio economic status spanning from 8th through 12th grades, found that in 8th grade 260 students of low SES categorized as "high-music" participants outperformed 1,216 low SES students (with no music involvement) in mathematics at a rate of approximately 20% vs. 10% - scoring at the highest levels of the mathematics proficiency scale. By their senior year in high school, the same 260 low SES, "high-music" students were again outperforming low SES no-music students by a much larger margin, approximately 33% vs. 15% for their non-music peers (Catterall et al., 1999).

Schellenberg (2004, 2006) conducted two studies on long-term associations between music lessons and IQ, with specific attention on the length of time students received music instruction. Schellenberg's research led to a suggestion of causality between length of participation in music instruction and IQ. Other research by Neville (2008) found that the improvement of attention resulting from music training leads to improved cognition, with specific gains on the puzzle assembly subtest of the Wechsler Intelligence Test.

In the past several years, research has continued to reveal similar findings of improvement in cognition, language processing, and even IQ through music instruction (Kaviani, Mirbaha, Pournaseh, & Sagan 2014; White, Hutka, Williams, & Moreno, 2013). In 2013, White et al., reviewed evidence for a bi-directional transfer of skills between music and language. Findings suggest that tonal language may enhance music processing and conversely that early music training may enhance language processing. One year later in a study of the effects of music instruction on the cognitive development of preschool children in Iran, statistical analysis showed a significant IQ increase in the children receiving music lessons (Kaviani et al., 2014). These findings appear to be consistent with some of the emerging neuroimaging and neurological observations.

The results of these and other studies point to the benefits of music instruction in the development of cognitive functions and personality. Music instruction helps a student mature by promoting a sense of accomplishment and fostering tangible increases in academic achievement (Baker, 2013; Cole, 2011; Hardiman, Magsamen, McKhann, & Eilber, 2009; Jonides, 2008; Neville, 2008; Olson, 2010). Research by Johnson and Memmott (2006) and others shows students in instrumental music programs performing better in language arts and mathematics than non-musical peers (Catterall et al., 1999). Skills gained from participation in band through exposure to music and requirements of rehearsal transfers to other cognitive functions involving memory, which in turn enhances academic success (Jonides, 2008). An extension of this finding is that more participation in instrumental music is likely to lead to academic success. Thus, research on the effects of music instruction provides support for music instruction in the schools because it aids academic achievement. The benefits of music instruction are overlooked because of the mandated accountability measures of No Child Left Behind and other accountability-based legislation (Armstrong, 2006; Major 2013).

Music and learning.

Research can help educators recognize the value of music education. A number of research studies from major universities have shown a relationship between music instruction and various forms of learning (Patoine, 2008; Spelke, 2008). For example, Cole (2011) compiled a range of university research findings supporting the existence of a strong direct relationship between the arts and student learning. Further findings from Elizabeth Spelke (2008) of Harvard University established a relationship between music and learning, specifically of geometric skills such as spatial sensitivity. Findings indicated mathematical advantages for music participants with extensive music training in tests related to abstract geometry, though not necessarily extending to other areas of math testing. Also, Brian Wandell of Stanford University described the relationship between reading fluency and music training. It was found that children with the ability to read rhythms and recognize pitches are more likely to be able to demonstrate reading fluency. Wandell also found a moderate relationship between music training and recall of a series of numbers (Cole, 2011).

In a definitive study in the field, Costa-Giomi (1999) found academic benefits to participation in piano lessons. Longley (1999) established that music provides cognitive skill improvement in critical thinking, problem solving, and decision-making. Aniruddh and Iverson (2007) found a link between cognitive music and linguistic abilities. Southgate & Roscigno (2009) utilized national datasets to determine the existence of associations between music and achievement, finding that positive associations persisted even when considering prior achievement. Southgate and Roscigno's work found that as an influence on educational outcomes, music involvement was significant for both mathematics and reading achievement. Moreover, Dreyden (1992) investigated instrumental music instruction and academic achievement including the independent variables of: gender, race, socioeconomic status, family structure, education level of the mother, and length of time in the school district. One finding from this comprehensive study was that band participants had statistically higher reading vocabulary and reading achievement than their non-instrumental peers.

More broadly, research indicates that music instruction may enhance not only cognitive abilities but also personal and social capabilities. For example, O'Connor and Paunonen (2007) correlated the non-cognitive trait of conscientiousness to academic success. Some of the skills and traits of conscientiousness include cooperation, teamwork, listening, communication, and focus on different tasks (Hollenbeck, 2008). Those who persist in instrumental music instruction have greater internal locus of control, higher self-esteem, and ability to put forth effort compared to those who dropped out (Schmidt, 2005). Hallam, (2010) studied the impact of musical skills on a number of areas, including language development, literacy, numeracy, and intelligence. The results showed a positive effect for musical engagement only when the musical experience was enjoyable and rewarding, suggesting that quality music instruction is essential for attainment of benefits from musical exposure (Hallam, 2010). Together, the work of these researchers "provides a strong case for the benefits of active engagement with music throughout the lifespan" (Hallam, 2010, p. 22).

Benefits of instrumental music instruction ally with Harvard professor Howard Gardner's (1983) cognitive theory of "multiple intelligences." Research has supplemented and supported Gardner's findings (Armstrong, 2009; Barry, 2008; Di Edwardo, 2005; Hollenbeck, 2008; Jensen, 1998; Petress, 2005; Rubinson, 2010; Tomlinson, 2003). Gardner holds that intelligence is the ability of an individual to solve problems or create products, which are valued within one or more cultural settings. He identified distinct "ways of knowing" the world and solving problems. These "ways of knowing" are the "intelligences." "In a nutshell, the evidence is persuasive that (1) our brain may be designed for music and arts and (2) a music and arts education has positive, measurable, and lasting academic and social benefits" (Jensen, 1998, p. 36). Another characterization of Jensen's findings is that the brain possesses distinct "musical intelligence" (Gardner, 1983).

Gardner suggested that individuals are able to excel in different areas, depending on their set of particular strengths or "intelligences." According to Gardner, there are nine intelligences, with one of these being musical intelligence. Gardner (1999) claims all humans have these intelligences, but some are more pronounced than others, depending on the person. They can either be nurtured or ignored. When students are able to develop and understand their own intelligences, they move toward managing their own learning and valuing their individual strengths (Thirteen Ed Online, 2004).

People who are strong in the area of music-rhythmic intelligence show sensitivity to melody, sound, and rhythm (Gardner, 1983). In fact, many of the other eight intelligences are fostered through participation in band, adding to the overall "intelligence" of the participating student (Gardner, 1983). Logical and spatial awareness are involved in music intelligence, which are important in mathematics processing (Cox & Stevens, 2006; Shaw & Peterson, 2003). “Chanting, clapping, tapping, dancing, and playing rhythm instruments and body percussion can teach students to feel and understand the segmentation of language necessary for phonemic and phonological awareness” (Rubinson, 2010 p. 52). Other skills related to Howard Gardner’s “intelligences” include (a) listening which is interpersonal, (b) communication which is verbal-linguistic, and (c) multitasking which is spatial (Hollenbeck, 2008).

Educators may come to recognize the value of music education when exposed to the research indicating its potential (Cole, 2011). Research studies from a variety of major universities (Harvard, Stanford, and others) have demonstrated a connection between music instruction and learning (Cole, 2011; Patoine, 2008; Spelke, 2008). Two common areas of research relating to music instruction and academics are language arts and math (Cole, 2011; Jonides, 2008; Spelke, 2008).

Music and language arts.

There is an abundance of research supporting the contention that musical involvement impacts Language Arts (DiEdwardo, 2005; Piro & Ortiz, 2009; Schneider & Klotz, 2000). Commonalities include improvement in cognitive processing, decoding, comprehension, and reading (Bugos & Jacobs, 2012; Hardiman et al., 2009; Butzlaff, 2000). The research strongly indicates music instruction can improve literacy. Research suggests that this improvement may be attained through the ongoing exposure of students to quality instrumental music instruction (Hallam, 2010, Kurt, 2010).

Butzlaff (2000) researched the connections between music instruction and reading performance, utilizing multiple studies and involving over 500,000 students. Butzlaff showed a strong association between music instruction and reading ability. Others have found that music can be utilized as a teaching tool to engage students in literacy as well (Fry & Newlin, 2010, Kurt, 2010). Fry and Newlin (2010) found music may be utilized to improve education through exposure of students to pertinent works of music during pre-reading, during reading, and in post-reading. Similarly, Kurt (2010) analyzed factors affecting achievement in literacy of eighth grade middle school instrumental music students, including factors such as socioeconomic status (SES), gender, and grade point average (GPA). Results indicated an association between students' literacy achievement and participation in instrumental music. Kurt also found indicators that participating in music instruction may impact cognitive functions that influence other disciplines.

Continuing to find strong connections between music and reading/literacy, Baker (2011) studied over 37,000 middle school students, considering both students that did receive music instruction and those that did not. The results *failed* to support the exclusion of students from music instruction. The students that did partcipate in music, despite their additional commitment required for music participation, performed significantly better than their counterparts (Baker, 2011). Similarly, research by Wallick (1998) and Hash (2011) provides a counter point to the assertion that students will benefit from a reduction in time dedicated to instrumental instruction. Hash (2011) analyzed the effect of pullout instrumental lessons on academic achievement of 8th grade students from a Midwestern school district during a three year period (2007 -2010). Data indicated that eighth-grade band students achieved significantly higher mean scores on the ACT Explore test than students who dropped band prior to eighth grade or never enrolled in band. The data also supported the assertion that pullout lessons had no negative impact on academic achievement, regardless of the number of years students were involved in the program, quashing the notion that pullout instrumental music instruction negatively affects achievement (Hash, 2011). Similarly, Babo (2004) conducted a study of the relationship between music and standardized testing of middle school students utilizing a statistical design to control for three major variables; intelligence quotient (IQ), gender, and SES. While IQ was found to be the strongest contributor to success, the results suggested that a significant relationship existed between instrumental music participation and academic achievement, with the strongest correlation in Reading/Language Arts (Babo, 2004).

Music facilitates literacy learning; for instance, studies show that verbal memory as well as verbal sequencing improve when students are involved in a music programs (Kurt, 2010). Dreyden found that band participants performed better in reading than non-participants, indicating vocabulary and reading ability is improved in those students who receive music instruction (Dreyden, 1992). Schneider & Klotz (2000) studied 346 students divided into three groups: musicians, athletes, and non-participants (that is, neither musicians nor athletes). Over the three years of the research, the musicians achieved significantly higher academic achievement scores than the athletes. The study specifically noted that musicians tended to maintain their scores while the athletes and non-participants group scores dropped (Schneider & Klotz, 2000).

Miksza's (2007b) longitudinal study utilizing the National Educational Longitudinal Study of 1988 drew correlations between music participation and academic achievement in a number of subject areas, including reading. Of the 5,335 high school students studied, those who participated in music scored higher on reading tests than their non-musical peers (and other tests as well). In addition, students who were active in music maintained their initially higher levels of academic achievement over time.

Research by Ho et al. (2003) found that music training improves verbal memory. Follow-up research by these researchers found that those students who continued the training continued to improve their verbal memory, while those who discontinued training ceased to improve. Also in the area of verbal development, Piro and Ortiz (2009) studied the impact of piano instruction on the development of vocabulary and verbal sequencing in an experiment involving 103 students in the second grade. The piano group had significantly better vocabulary and verbal sequencing scores by the end of the study, but prior to the study they had already been playing piano for two years without any differences in reading between their skills and those of the control group. Piro and Ortiz found that there are benefits for engaging in musical activities in relation to reading beyond those associated with language development (Piro & Ortiz, 2009). Results of research related to literacy development by Pane and Salmon showed that music facilitates literacy learning (Pane & Salmon 2011). The pairing of linguistic and music intelligences triggers cognitive functions in the brain required for reading and writing (DiEdwardo, 2005).

Music and mathematics.

There is a significant body of research showing a positive relationship between music and mathematics, that is, between the cognitive abilities underlying music and the cognitive abilities underlying mathematics performance. Whether based on neurological development related to brain stimulation (Rauscher, Shaw, & Ky, 1993) or through the acquisition of skills linked to music participation (Southgate & Roscigno, 2009) a great deal of research reveals the positive benefits of music instruction for mathematical performance (Zanutto, 1997).

In the early 1990s, Rauscher et al. (1993) conducted groundbreaking research establishing a causal relationship between music instruction and academic achievement, specifically focused on how stimulation of certain parts of the brain corresponds to the relationship between music and mathematics. The work has been termed, “The Mozart Effect.” Zanutto (1997) found significant differences in academic achievement between instrumental and non-instrumental students in several core subject areas, including mathematics. Hetland (2000) built upon Rauscher, Shaw, and Ky and others’ work, conducting a meta-analysis of published and unpublished studies on music and spatial skills. Hetland found “confirmatory evidence” that the “Mozart Effect” is strong and consistent, with no significant difference between males and females (Hetland, 2000).

Two years later, Bugos and Jacobs (2012) continued on Heltand’s path demonstrating a connection between music and mathematics, with research indicating that experiences with musical notational symbols, sequence creation, and compositional concepts positively impact student performance in traditional core subject areas including mathematics. Among other things, Bugos and Jacobs concluded that the potential exists for music to enhance competency in mathematics, specifically due to its impact on spatial-temporal reasoning skills: defined as mental rotation or *spatial visualization in the absence of a physical model* (Hetland, 2000). Parallel research, establishing a possible connection between music and spatial-temporal reasoning, Bilhartz, Bruhn, and Olson, (1999) studied the impact of instrumental music instruction on spatial temporal, mathematical, and verbal reasoning of four and five year old students, through the use of six different tests. Results showed the music group outperforming the control group on the Bead Memory test, but not on any of the other five. The work provides additional evidence of the link between music training and spatial-temporal reasoning (Bilhartz, Bruhn, & Olson, 1999), Over the next several decades, numerous studies solidified the relationship between music and mathematics first established by Rauscher et al. in 1993 (Argabright, 2005; Graziano, Peterson, & Shaw, 1999; Hallam, 2010; Schneider & Klotz, 2000). Graziano, Peterson, and Shaw (1999) conducted quasi-experimental research involving video games that provided a foundation for understanding the relationship between music, spatial reasoning, and spatial aspects of mathematics, finding spatial-temporal connections similar in scope to those found by Bilhartz et al. (1999). While this quasi-experiment provides moderate evidence of causation by ruling out competing explanations for the observed effects, random selection and student assignment to the various groups in the study would have strengthened the validity of their findings. Nonetheless, Graziano et al. work (1999) stands as a convincing barometer for the connection of instrumental music to achievement in math.

One of the more involved studies was a longitudinal study linking music to mathematics achievement conducted by Southgate & Roscigno (2009). The study involved over 12,000 students and examined the relationship between achievement in mathematics and participation in music. It looked at learning outcomes for 4,376 kindergarten and 1st grade students, in addition to 7,781 high school students in grades 8-12. Their research findings suggested a positive relationship among participation in music, parent involvement in music, and achievement in mathematics for kindergarten and first grade students. For high school students, there was a positive relationship between participation in music and achievement in mathematics.

Other research continued to build upon the connection between music and mathematics, in some cases specifically studying musical rhythm and its effects. The outcome of Rauscher's work (2009) suggested that rhythmic training is the aspect of musical instruction that is important for the development of temporal cognition and mathematics. The following year, Hallam (2010) found that students who received instruction on rhythm instruments scored higher on part-whole mathematics problems than those receiving piano and singing instruction. In addition to rhythmic aspects of music, other links between music and mathematics include foundations in time and counting systems, as well as overtone structure, and tuning systems (Schneider and Klotz, 2000). Pattern identification and recognition as well as transcription of music on paper (graphing) are also areas where the areas of music and mathematics intersect (Argabright, 2005).

Davenport (2010) found that students who received formal instrumental instruction demonstrated a positive correlation with achievement in algebra, with the findings consistent across variables of race. All students with music instruction performed better in algebra than their counterparts of the same race without music instruction. This analysis supports the theory that music instruction is positively correlated to achievement in mathematics (Helmrich, 2010).

Instrumental music and the achievement gap.

Closing the achievement gap is one of the primary purposes of educational legislation and the accountability movement, particularly NCLB (Editorial Projects in Education, 2011). Unfortunately, the decade-plus worth of gathered evidence since the passage of NCLB demonstrates a law that has failed in terms of its own goals, and the result has been over a decade of educational stagnation (Guisbond, Neill, & Schaeffer, 2012). A major report conducted by the National Center for Fair and Open Testing found that NCLB failed to significantly increase average academic performance or significantly narrow achievement gaps, as measured by the U.S. Department of Education's National Assessment of Educational Progress (National Center for Fair . . . , 2014). In this light, particularly due to implications of discrimination relating to race, some have called closing the achievement gap the civil rights issue of our time (Lohela, 2013).

The failure to meet the standards set forth by NCLB has led to an even greater decrease in funding for the arts, including instrumental music instruction. In the wake of often devastating budget cuts, music programs including instrumental music have continued to be stripped from schools largely because they are not one of the "core" subjects (reading, mathematics, and science) evaluated on standardized tests (Beveridge, 2010). This situation presents a contradiction, as music has been found to help students achieve in tested areas such as mathematics, reading, and science (Kinney, 2008). NCLB continues to damage educational quality and equity by disproportionately focusing attention on the limited skills that standardized tests measure (Guisbond et al., 2012). In many cases around the United States, the result of NCLB's failure has been a reduction in the numbers of music instructors and the elimination of entire music programs (Beveridge, 2010).

Arts education, particularly instruction in instrumental music, can be used to close the achievement gap (Catterall & Dumais, 2012). According to a study by the National Endowment for the Arts (NEA) titled, *The Arts and Achievement in At-Risk Youth: Findings from Four Longitudinal Studies,* students with high arts educational experience significantly outperformed their peers in numerous combinations of subjects and grade levels, including those of low socioeconomic status (Catterall & Dumais, 2012). Research continues to demonstrate arts and music instruction can narrow the achievement gap (Dobb, 2010; Salazar, 2012). Studies comparing outcomes for students from low vs. high SES backgrounds, and low vs. high participation in arts activities demonstrated that students with high participation in the arts outperformed students with low participation in the arts in a number of areas including academic and civic outcomes (Catterall & Dumais, 2012). In fact, students from low SES backgrounds did particularly well.

In 2011, the National Endowment for the Arts (NEA) examined the behavior of teenagers and young adults who substantially engaged in the arts, utilizing four large national databases to analyze the relationship between arts involvement and achievement (O'Brien, 2012). By nearly every indicator studied, students from a low SES with high-arts education significantly outperformed peers from low-arts, low-SES backgrounds. In many cases, the SES achievement gaps were closed and even eliminated (O'Brien, 2012). Miksza (2007b) conducted a longitudinal study examining correlation between music participation, academic achievement, and socioeconomic status in high school students; finding that the students involved in music scored consistently higher on academic achievement tests in math, reading, science, and social studies than students reporting no music participation. Moreover, students in music maintained higher levels of academic achievement over time, regardless of socioeconomic status. In another study supporting the contention that music instruction is a factor or *tool* for narrowing the achievement gap, Salazar investigated the correlation between music education and racial achievement gaps in a study of almost 12,000 students in nine Florida high schools, finding a lower achievement gap in cases where students have a record of music enrollment (Salazar, 2012).

In summary, despite these findings many educational leaders believe that the "solution" to closing the gap is to provide underperforming groups with more intensive academic instruction in the core subjects, which is to the detriment of music and art education. Even with implementation of these solutions, the gap persists, but the impact of retaining or initiating instrumental music programs in order to shrink or eliminate the SES achievement gap is promising (Dobb, 2010, Catterall & Dumais, 2012). However, instrumental music has not been among the reform tools commonly used to attempt to eliminate the achievement gap. Common reform recommendations have included expanding early childhood programs, creating smaller schools, reducing class sizes, raising academic standards, improving the quality of instruction for poor and minority students, and encouraging more minority students to take high-level courses (New Jersey Education, 2011).

Music and standardized test scores.

Two common themes emerge from the research relating to music and standardized test scores. The first is that students are not negatively impacted by music instruction, even when they are pulled out of classes in order to receive that instruction (Corral, 1998; Hash, 2011; Holmes, 1997; Miksza, 2007a). The second is that music instruction bears great potential for increasing standardized test scores in students (Dreyden, 1992; Kinney, 2008; McLelland, 2005; Neville, 2008; Trent, 1996).

A significant number of students in the United States receive some part of their music instruction through pullout lessons during the school day, spurring an argument that this practice should be stopped due to the lost instructional time in core classes (Hash, 2011). In the late 1990s Wallick (1998) and Corral (1998) conducted research on this topic. Corral's hypothesis that pullout programs have no negative effect on academic achievement was proven true with no significant difference between the two groups of pullout and non-pullout students (Corral, 1998). Wallick's findings paralleled Corral's. In comparing pullout music students against their ability matched peers on the writing, reading, mathematics, and citizenship parts of the Ohio Proficiency Test (OPT) Wallick found that in reading and citizenship the pullout instrumental music students actually scored statistically higher than the non-instrumental students.

Research has continued to demonstrate that there is no negative effect for pullout instruction on academic outcomes. Hash (2011) studied over 300 8th grade students; the data showed that band students achieved significantly higher mean scores on the ACT Explore test than their non-band counterparts. It should be noted that Hash's work indicated that band students tended to be more academically successful than non-band students at the outset of their participation (Hash, 2011). Demonstrating similar outcomes, Thornton (2013) compared standardized test scores between voluntary music students and non-music students, showing that those involved in music earned higher scores on state mandated standardized tests than those not involved in music, despite the investment of time required for participation in musical activities.

Overall, the preponderance of research refutes the notion that pullout instrumental music instruction negatively affects any assessment outcomes, and by extension NCLB mandated AYP testing (Wallick, 1998, Gouzouasis, 2007, Hash, 2011, Thornton, 2013). The time that a student dedicates to participation in music instruction does not impede, but rather fosters academic achievement in other ‘core’ subject areas (Gouzouasis, 2007).

> Many administrators, teachers, and parents assume that providing instruction through pullouts will cause a decline in scholastic performance due to missed class time. Research, however, has found no significant difference between the academic achievement of students who left class for instrumental study, and those who did not, regardless of school size and student background. (Hash, 2011, p.1)

Research has consistently demonstrated that instrumental music instruction has a positive impact on testing outcomes (Neville, 2008). Dreyden (1992) found higher reading vocabulary and total reading achievement scores for band students than those who were not involved in band (Dreyden, 1992). Trent’s (1996) study of extracurricular activities built upon Dreyden’s findings, solidifying the link between music and test scores. Trent’s study uncovered further supporting evidence that extracurricular activities such art and music gave students an advantage on standardized tests, earned GPA, and levels of interest in college. In a similar vein, McLelland (2005) found a statistically significant difference between the reading and mathematics achievement scores of 5^{th} grade students based on the presence or absence of music instruction. The instrumental music participants had a mean standardized test score 8.5 points higher in mathematics, and 7.9 points higher in reading, than their non-participating counterparts. All these findings support the recognition of a positive relationship between music instruction and higher scores on standardized tests. This relationship holds up across a range of testing areas including mathematics, writing, and reading (Kreeft, 2006).

The Scholastic Aptitude Test (SAT) is a test utilized by many colleges and universities as a part of the admissions decision process (Pederson, 2007). Positive correlations have been found between music instruction and SAT scores in a number of cases. The Texas Music Educators Association (2014) reported the following statistics (Table 1) relating to band members' SAT scores compared against state and national averages.

Table 1

Composite SAT Scores (Texas)

	2008	***2009***	***2010***	***2011***	***2012***
All-State Band Students	1819	1835	1857	1852	1825
National Average	1511	1511	1509	1509	1500
State Average	1481	1473	1467	1462	1434

A question arises whether the improvement in testing was due to instrumental music specifically, or to music instruction in general. Kinney (2008) studied choral and band participation in an urban middle school, analyzing test scores in reading, mathematics, citizenship, and Science. Kinney found that students who participated in band showed significant improvement in achievement, while choral participation did not show similar results. Research also indicates that music instruction enhances student performance on standardized tests, which consequently reduces the achievement gap for students from low socioeconomic groups (Dreyden, 1992, Trent, 1996, McLelland, 2005, Neville, 2008, Kinney, 2008).

Is it the music that makes the difference?

Not all research is as strongly suggestive relating to the impact of music instruction on closing the achievement gap as Salazar's work in Pinellas County, Florida, or the findings of the

National Education Association 2011 report. Studies by Fitzpatrick (2006), Gillmeister (2008), Hash (2011), and Elpus (2013) were inconclusive and suggested that there may not be a correlation. Their work indicated that students who participated in music programs may have been high academic achievers before they entered the music program, suggesting that students enrolled in these programs would have scored well on standardized tests whether they were in music programs or not.

Fitzpatrick's (2006) study found that instrumental students at both high and low SES demonstrated higher scores than their non-instrumental counterparts in the fourth grade even before participation in music, suggesting that instrumental music programs attract higher scorers from the start. Similarly, while controlling for variables relating to demography, prior academic achievement, time use, and student attitude toward school, Elpus (2013) found that music students did not outperform non-music students on the SAT once these variables had been statistically controlled. Hash's (2011) work indicated that band students tended to be more academically successful than non-band students at the outset of their participation. Finally, while Gillmeister (2008) showed a statistically significant increase in mathematical achievement for students participating in instrumental music instruction, subjects in the study self-selected whether or not they would receive music instruction. This leaves open the possibility that the instrumental music participants began with a higher achievement level than their peers.

Conclusion.

"Despite the strong supporting evidence, the arts remain on the fringe of education. Music classes are often the last to be added and first to be dropped in hard economic times" (Judson, 2012, p.8). As the President's Committee on the Arts and the Humanities concluded in their 2011 report, "Reinvesting in Arts Education," the educational system's narrow focus on teaching the basics has not been the answer for a large proportion of American students. Many graduates do not possess the skills essential for achieving success in post-secondary education and beyond as they migrate to the work force. Their report addresses essential 21st century skills which must be taught to students including problem solving, critical and creative thinking, addressing ambiguity and complexity, integration of multiple skill sets, and disciplinary work (President's Committee on the Arts and the Humanities, 2011).

Catterall and Dumais's work (2012) reinforced the President's Committee's findings, by revealing that students from arts backgrounds, from both low and high socioeconomic strata, are more likely to choose professional majors in college such as accounting, education, and nursing. Moreover, compared to their non-musical peers, students from musical backgrounds are more likely to aspire to professional careers in management, sales, and teaching. Art and music instruction should be viewed as complementary to student achievement on standardized tests, rather than a hindrance. Phillips (2008) described the No Child Left Behind Act as legislation that prevents students from excelling in school. The legislation's demand for improvements in mathematics and reading achievement has led to increased instructional time and coursework in mathematics and English language arts while co-curricular programs often associated with improved academic achievement are becoming obsolete (National Education Association, 2010). Schellenberg conducted two studies on long-term associations between music lessons and IQ showing a positive correlation between the two (Schellenberg, 2004; Schellenberg, 2006).

Students actively involved in music are more likely than their non-participant peers to achieve success in both the academic environment and in society (New Jersey Education, 2011). A recent study of workforce readiness found that employers increasingly value applied skills such as problem solving, collaboration and creativity (Landrum, Hettich, & Wilner, 2010). More specifically, business leaders from major corporations such as Xerox, GlaxoSmirthKline, and Google have articulated their belief that music aids students in acquiring skills needed in the workplace including flexibility, effective communication, creativity and innovation (Judson, 2012).

Educational policymakers could leverage the benefits of music instruction, particularly for disadvantaged students by developing instrumental music programs that support the low budget schools and "at risk" students (Guisbond, Neill, & Schaeffer, 2012). Instrumental music may serve to help students who border on dropping out of school (Barry, Taylor, Wallis, & Wood, 1990). Students from low-socioeconomic (SES) backgrounds with high-arts educational experiences have been found to significantly outperform peers from low-arts, low-SES backgrounds (O'Brien, 2012). Formal music instruction could reduce achievement gaps related to race as well, having been found to affect achievement of black students more than the achievement of white students (Helmrich, 2010).

Music instruction is essential in the American school system. The Children's Music Workshop mirrors the sentiment of many researchers describing how music contributes to the school and community environment, helping prepare students for a career. Additionally, music makes the day more alive and interesting, leading to more learning and higher order thinking (Children's Music Workshop, 2013). United States Secretary of Education Arne Duncan recently stated, "Education in the arts is more important than ever. In the global economy, creativity is essential. Today's workers need more than just skills and knowledge to be productive and innovative participants" (Judson, 2012, p.1). Instrumental music instruction may prove itself to be an effective and valuable weapon in the battle to reduce and eventually eliminate the educational achievement gap, which increasingly prevents countless American students from living up to their potential (Thomas, 2011).

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2 BAND ON THE BRAIN: INSTRUMENTAL MUSIC AND STUDENT ACHIEVEMENT

For the past 20 years, non-core programs such as instrumental music instruction have been cut in many American schools (Major 2013). This is largely due to the failure of the accountability movement in education to adequately inform educational policy makers about the positive impact of instrumental music and other similar programs on student achievement (Major 2013). Instrumental music instruction can help students perform better in subject areas where schools are being held accountable, like reading and math (Armstrong, 2006). This work is an attempt to understand the impact of instrumental music participation on academic achievement by analyzing standardized test scores. Specifically, this dissertation focuses on academic performance in mathematics and reading by investigating the question, "to what extent does school-based instrumental music instruction impact the learning outcomes of a cohort of high school students in a private Catholic school setting?"

This research provides insight into the study of instrumental music and its impact on academic achievement as measured by performance on standardized tests, specifically for 8^{th} – 12^{th} grade students. The Catholic school is located on a suburban campus in northern Georgia. A total of 802 students attended grades PreK-3 through 12^{th} grade in the 2013-2014 academic year. The student body is predominantly middle to lower-upper class, 75% Caucasian, 12% Hispanic, 6% Asian, 1% African American, and 6% of mixed race. The lower school, made up of grades PreK-3 through 5, enrolled 337 students. The middle school, made up of grades 6-8, is self-contained in its own building and distinct area on the campus, and enrolled 189 students in the 2013-2014 academic year. The high school is in its own building and distinct area on campus and had 276 students enrolled in 2013-2014. Table 5 (p.76) provides a summary of the grade specific demographic breakdown of the students included in the study.

Forsyth County, where the school is located, had a population of approximately 195,000 in 2013, with 86.4% of residents being Caucasian. The average median household income for Forsyth County from 2008-2012 was $87,585, compared to $49,604 for the state of Georgia (United States Census Bureau, 2014). Tuition at the private Catholic school averaged $13,500 for the 2013-2014 academic year. The curriculum design in the school is college preparatory, with one hundred percent of graduates continuing formal education at a four-year institution.

Research design.

The study was designed to use historical data from school records to compare the standardized test scores of band students in the school to those of non-band students.

Hypothesis: The test means of band participants are greater than the test means (reading and math) of the comparison group.

Null Hypothesis: The test means of band participants are not greater than the test means (reading and math) of the comparison group.

Selection bias is a concern in research because it may lead to inaccurate or biased estimates. Selection bias happens when sample participants or observations are not randomly drawn from the population, thus inferences about that population based on the selected sample are biased due to self-selection or some other variable (Lewis-Beck, Bryman, & Liao, 2004). In order to attempt to address the self-selection bias of the band and non-band students studied, propensity score matching (PSM) was used to develop the comparison and treatment group for this study. A propensity score provides the probability of participation in the treatment, e.g. band participation, based on observed baseline characteristics e.g. student attributes, socioeconomic factors.

The propensity score allows the researcher to conduct an observational (nonrandomized) study in a way that mimics some of the characteristics of a randomized controlled trial. In essence, the propensity score is a type of balancing score. The distribution of observed baseline covariates will be similar between treated and untreated subjects, conditional on the propensity score (Austin, 2011). After a matched sample is established, the treatment effect may be estimated by directly comparing outcomes between the treated and untreated subjects in the matched sample. If the outcome is continuous, the effect of treatment can be estimated as the difference between the mean outcome for treated subjects and the mean outcome for untreated subjects in the matched sample (Austin, 2011; Rosenbaum & Rubin, 1983). If the outcome is dichotomous, the effect of treatment can be estimated as the difference between the proportion of subjects experiencing the event in each of the two groups in the matched sample (Austin, 2011).

The research design uses standardized test scores in math and reading as a measure of student achievement after instrumental music instruction. The methodology and analysis were conducted in two main parts. The first part of the study (Part 1) involved selecting adequate comparison and treatment groups through PSM. The PSM in Part 1 involved conducting individual propensity matches for students within each of the classes studied (2014, 2015, 2016, 2017, and 2018). There were a total of 80 matched students. In Part 2 of the study, regression analysis was utilized to determine whether or not band participation was associated with standardized test scores in reading and math.

The conditional propensities are used to identify the degree to which the compared groups are observationally equivalent (Austin, 2011). The dependent variable for the propensity score, band, is a categorical variable indicating whether or not a student participates in band. Independent variables are gender, ethnicity, standardized test scores, and subject grades. The sample included the 206 students in 8th – 12th grade who attended the school for the entire 5 years the band program was in existence. Due to incomplete enrollment and attendance record keeping prior to the 2011-2012 academic year, it is impossible to definitively compare attrition rates of band and non-band students, though the band director articulated that the attrition rate in band was low – less than 10% annually, which is in line with the 92% retention rate of the school as a whole since the 2011-2012 academic year. The probabilities estimated from Part 1 were used to create the treatment (33 students) and comparison group (47 students) used in Part 2.

Part 2 involved multiple linear regressions used to answer the question of whether or not a statistically significant difference exists between the standardized test scores in reading and math of band students compared to their non-band peers. Regression analysis fits straight lines to patterns of data. In a linear regression model, the variable of interest, the dependent variable, is predicted from other variables, the "independent" variables, using a linear equation (Nau, 2014). The dependent variable is student test scores for reading and math, and the independent variables were the categorical variables indicating band and non-band participation, propensity score, conduct, and attendance. Part 2 used SAT-10 scores for 8th grade and PSAT scores for 9th -11th grades. The stratified PSM of the 12th grade in Part 1 found no matches, so no students from the class of 2014 were included in the Part 2 analysis. Analysis and implementation of the proposed methodology were conducted using IBM SPSS Statistics 22 software. Propensity score matching in the study was accomplished using Propensity Score Matching for SPSS software (version 3), an SPSS dialogue programmed by Thoemmes and Liao that works with existing R packages for propensity scoring.

Results of the study will not be generalizable to the overall student population. Because the sample covers students at a private Catholic school in the northern suburbs of Atlanta, the results may apply to Catholic and independent schools in suburban locations, with students from similar socio-economic and racial backgrounds.

Significance.

This work presents research from a private Catholic school environment, where a new instrumental music program was initiated 5 years ago in the 2009-2010 academic year. The work is unique in that the majority of existing research on this topic utilizes public school students (Davenport, 2010; Elpus, 2011; Lacour, 2010; Legette, 1993; McLelland, 2005; Miller, 2013; Murphy, 2013; Schneider, 2000), and few studies involved a treatment time of 4-5 years. Additionally, the researcher was unable to identify any prior research in this area utilizing propensity score matching to address the issue of selection bias.

Also, there is value in ascertaining if any academic effect is correlated with participation in the music program. This work may lead to an increase in awareness of the possible benefits of implementation of instrumental music programs in schools, resulting in potential improvement in learning outcomes for students. Finally, this work is unique in that it utilizes a stratified PSM to identify comparison and treatment groups. No other study relating to instrumental music and academic achievement was found using PSM.

Guiding questions.

The major question guiding this study is, “Does school-based instrumental music instruction lead to a statistically significant difference in the learning outcomes of a cohort of high school students in a private Catholic school setting?” The hypotheses examine:

1. Does a statistically significant difference in language arts standardized test scores exist between band participants and non-participants?

2. Does a statistically significant difference in math standardized test scores exist between band participants and non-participants?

Assumptions and limitations.

Several assumptions are made in this study. The first is that the propensity score match process will adequately address the aforementioned selection bias concern relating to the band and non-band students in the study. A second assumption is that socio-economic selection bias potentially affecting students choosing to participate in band is remediated by the homogeneous socio-economic nature of the population studied. While the methodology can indicate a relation between the impact of instrumental music and academic outcomes, results will not be generalizable to the overall student population.

An issue for consideration is the selective nature of admissions for the private Catholic school under study. The rigorous behavioral and academic standards of the admissions process leads to an academically elite student population and the increased likelihood that any new program's success may be disproportionately high. Students with the weakest academic and disciplinary credentials are unavoidably excluded from the study population. This results in a starting point of a pool of students with a high probability of high grades and standardized test scores. The instrumental music program under study was conceived, instituted, and exists under the aforementioned circumstances of the student population where the test scores of top tier and low tier students do not vary significantly.

Conceptual framework.

The epistemology of this study is objectivism, which says all human knowledge is reached through reason (Crotty, 2008). As described by Roderick (2008), objectivism holds that knowledge is an understanding of reality reached by perceptual observation or through reasoning based on perceptual observation. It is predominantly a mathematical process of measurement. If a statement is made identifying a fact of reality it “corresponds” to reality, meaning it is “true.” If a statement contradicts a fact of reality, then it is false. According to Roderick, objectivists believe humans can gain certain knowledge when evidence for a given idea is conclusive within a certain context, all the evidence supports this idea, and there is nothing known which supports an alternative idea or theory. In this way, objectivism is the gaining of knowledge through reason (Roderick, 2008). Relating to this research, objective reason will inform the conclusions reached in the quasi-experimental research through the findings of statistical analysis that supports or refutes the hypothesis. The science behind the statistical model involves two steps. The first is the collection of evidence regarding the effect of band participation and academic performance. The second is the subsequent establishment of evidence of any cause-and-effect relationship between these two factors. This in turn, says something about the reality of the effects of participation in band.

The theoretical perspective is post-positivism, typically partnered closely with objectivism. The post-positivist perspective holds, “that the way scientists think and work and the way we think in our everyday life are not distinctly different. Scientific reasoning and common sense reasoning are essentially the same process. There is no difference in kind between the two, only a difference in degree” (Trochim, 2006, p.1). If the positive effect of band participation on academic performance is established, then we have learned something that may have important ramifications upon the public policy regarding education. This study used a quantitative methodology (specifically, logistic and linear regression) to assess the relationship between instrumental music instruction and student achievement in mathematics and reading.

Instrumental music and student achievement.

Instrumental music has provided many students with an exposure to a variety of learning experiences that can manifest a positive and lasting influence on youth development (Davenport, 2010). However, during the last several decades of education in the United States there has been a dramatic shift toward an emphasis on standardized test scores in core subject areas such as reading, mathematics, and science. This emphasis on core subjects and standardized tests, as the primary measure of academic success, has had the effect of marginalizing non-core subjects such as physical education, art, chorus, and instrumental music (Armstrong, 2006).

The accountability movement in American education has shifted focus toward an emphasis on standards and testing, limited to a few targeted subjects, requiring that schools make incremental Adequate Yearly Progress (AYP) until all students reach the goal of 100 percent proficiency in the main academic subjects (Armstrong, 2006). Ignoring and reducing music instruction due to the accountability movement's emphasis on other core areas continues despite the fact that research in the past decade has established significant connections between music instruction and academic achievement (Gadberry, 2010; Hash, 2011; Hollenbeck, 2008; Ruppert, 2006; Salazar, 2012; Southgate & Roscigno, 2009). Music has been shown to be a potential tool in the effort to reduce the achievement gap between various ethnic groups – a problem the United States government has attempted to address (SEDL, 2011).

Private Catholic and other independent schools such as the school in this study face financial challenges similar to their public school counterparts. As an example, in March of 2015 the school in this study announced a new band fee of $500 per student to participate in the high school band beginning in the 2015-2016 academic year. While the aforementioned concerns of the public school system relating to socio-economic status and achievements gaps potentially addressed by instrumental music programs may not apply as directly to private schools, the value of establishing and communicating the value of instrumental music programs to academic achievement is something all schools have in common, lest music programs be cut or priced out of existence for an increasing number of American students. As James Catterall (2013), professor in UCLA's Graduate School of Education & Information Studies and prominent researcher and advocate for the study of music in schools recently wrote:

> When music or any of the visual and performing arts was seen to go head-to-head with reading development or mathematics learning, music takes little away from that table. There is no reason to think of, say, basketball players and student musicians as interchangeable. Both need ways of engaging their passions and, by the time they reach high school, their passions differ. Both are positive in many ways; the arts promote more success than athletics in college.

The accountability movement and shifting educational priorities.

The accountability movement in education can be traced back with varying scope and degrees of implementation to the early 1900s (Hansen, 1993). In its most recent form beginning in the 1990s, accountability has increasingly been employed as a tool for educational reform on a national scale (Hansen, 1993). A major component of the accountability movement is the No Child Left Behind Act (NCLB) of 2001 (Armstrong, 2006). Since its inception, practical implementation of No Child Left Behind Act has been difficult, and it can be argued that its focus on "one-size-fits-all" standardized testing has in some ways undermined other potentially beneficial education reform efforts (Guisbond, Neill, & Schaeffer, 2012). One area of education that has been significantly impacted is instrumental music.

> In an age of increased accountability and educational standardization accompanied by tighter budgets and fewer funds, core subjects, such as mathematics and reading, receive more funding and instructional time in public schools, while non-core subjects, like music, potentially face reductions or elimination in budgets, programs, & staffing. (Major, 2013)

Indeed, the push for higher test scores has negatively impacted instructional time dedicated to non-core subjects such as band, chorus, and art, as evidenced in Texas, where research including 349 public school districts showed an increase of instructional time for subjects like mathematics, science, and reading in all districts, with corresponding decreases of instructional time for the arts (Heilig, Cole, & Aguilar, 2010). NCLB impairs what art and other non-core classes can do for students by confining them to the method of learning strictly based on traditional subjects (Surber, 2010 p.1). As the United States Department of Education reports:

> Administrators recognize that more time is needed to teach such critical core subjects such as Algebra I. Class schedules are typically changed in order for teachers to have longer blocks of time that allow for instructor-led as well as applied instructional strategies. Administrators recognize the need to change classroom practices to allow students the opportunity to practice skills. (U.S. Department of Education, 2005, p. 3)

Out of this educational environment, with its emphasis on standardized testing and higher scores in “core” subjects, comes an emerging crisis for the performing arts (Beveridge, 2010). “Some of the short-term effects of this law have troubling implications for subjects that are not evaluated for the purposes of determining adequate yearly progress (AYP), the measure that serves as the basis for all federal funding” (Beveridge, 2010, p.4). States have cut billions of dollars from education budgets. For example, in Georgia, state legislators and governors cut well over $2 billion in public school funding since 2002 (Shearer, 2014). “The consequences for the arts include everything from the elimination of instrument repair budgets to the loss of entire teaching positions and programs” (Beveridge, 2010, p.5). Further, the requirement for more instructional time committed to “critical core subjects”, particularly for students at the lower end of the achievement gap, frequently results in reduction of class time for subjects like art and the performing arts, including band (Whitehorne, 2006).

Music and academic achievement.

For the last few decades of the 20th century, and accelerating significantly in the 21st century, connections have been found between student participation in school instrumental music programs and higher achievement, improved school attendance, increased cognition, and improved attention (Babo, 2004; Olson, 2010; Schellenberg, 2006; Thomas, 2011). Studies of proficiency showed an even stronger correlation between instrumental students and higher scores, specifically in reading and mathematics (McLelland, 2005). Other studies from the period and in the following decades found similar connections to academic achievement (Costa-Giomi, 1999; Gadberry, 2010; Southgate & Roscigno, 2009; Trent, 1996).

One question that is important to address is whether or not the relationship between instrumental music instruction and higher scores is due to the music, or attributable to self-selection of students into music programs (Elpus, 2013; Fitzpatrick, 2006; Hash, 2011; Kinney, 2008). Consistent with the findings of Fitzpatrick (2006) and Elpus (2013), Hash's work indicated that band students tended to be more academically successful than non-band students at the outset of their participation (Hash, 2011). The research indicated that students enrolled in music programs would have scored well on standardized tests whether they were enrolled in music programs or not. (Elpus, 2013, Fitzpatrick, 2006, Hash, 2011).

Despite the recent findings by Elpus (2013) that suggest music students at the onset are high achievers, other studies have shown a possible connection between music instruction and actual increases in intelligence and/or cognition (Andrich, 2012; Blasi & Foley, 2006; Catterall et al., 1999; Fitzpatrick, 2006; Hanna, 2007; Johnson & Memmott, 2006; Petress, 2005; Schellenberg, 2006). Even though music students may be high achievers at the onset the positive effect of music instruction is discernable when one considers time-span. Catterall, Chapleau, &

Iwanaga (1999) found that mathematics skills continued to improve for students exposed to music over time.

Research has continued to reveal similar findings of improvement in cognition, language processing, and even IQ through music instruction (Kaviani, Mirbaha, Pournaseh, & Sagan 2014; White, Hutka, Williams, & Moreno, 2013). In 2013, White et al., reviewed evidence for a bi-directional transfer of skills between music and language. Findings suggest that tonal language may enhance music processing and conversely that early music training may enhance language processing. One year later in a study of the effects of music instruction on the cognitive development of preschool children in Iran, statistical analysis showed a significant IQ increase in the children receiving music lessons (Kaviani et al., 2014). These findings appear to be consistent with some of the emerging neuroimaging and neurological observations.

Music and learning.

Two parallel themes relating to music and musical instruction over the past several decades is the role they may play in the development of cognition and enhanced academic achievement. In a definitive study in the field, Costa-Giomi (1999) found academic benefits to participation in piano lessons. Longley (1999) established that music provides cognitive skill improvement in critical thinking, problem solving, and decision-making. Aniruddh and Iverson (2007) found a link between cognitive music and linguistic abilities. Southgate & Roscigno (2009) utilized national datasets to determine the existence of associations between music and achievement, finding that positive associations persisted even when considering prior achievement. Southgate and Roscigno's work found that as an influence on educational outcomes, music involvement was significant for both mathematics and reading achievement.

Benefits of instrumental music instruction ally with Harvard professor Howard Gardner's (1983) cognitive theory of "multiple intelligences." Research has supplemented and supported Gardner's findings (Armstrong, 2009; Barry, 2008; Di Edwardo, 2005; Hollenbeck, 2008; Jensen, 1998; Petress, 2005; Rubinson, 2010; Tomlinson, 2003). Gardner holds that intelligence is the ability of an individual to solve problems or create products, which are valued within one or more cultural settings. He identified distinct "ways of knowing" the world and solving problems. These "ways of knowing" are the "intelligences." "In a nutshell, the evidence is persuasive that (1) our brain may be designed for music and arts and (2) a music and arts education has positive, measurable, and lasting academic and social benefits" (Jensen, 1998, p. 36).

Educators may come to recognize the value of music education when exposed to the research indicating its potential (Cole, 2011). Research studies from a variety of major universities (Harvard, Stanford, and others) have demonstrated a connection between music instruction and learning (Cole, 2011; Patoine, 2008; Spelke, 2008). Two common areas of research relating to music instruction and academics are language arts and math (Cole, 2011; Jonides, 2008; Spelke, 2008).

Music and language arts.

There is an abundance of research supporting the contention that musical involvement impacts Language Arts (DiEdwardo, 2005; Piro & Ortiz, 2009; Schneider & Klotz, 2000). Commonalities include improvement in cognitive processing, decoding, comprehension, and reading (Bugos & Jacobs, 2012; Hardiman et al., 2009; Butzlaff, 2000). The research strongly indicates music instruction can improve literacy. Research suggests that this improvement may be attained through ongoing exposure of students to quality instrumental music instruction (Hallam, 2010, Kurt, 2010).

Butzlaff (2000) researched the connections between music instruction and reading performance, showing a strong association between music instruction and reading ability. Others have found that music can be utilized as a teaching tool to engage students in literacy as well (Fry & Newlin, 2010, Kurt, 2010). Fry and Newlin (2010) found music may be utilized to improve education through exposure of students to pertinent works of music during pre-reading, during reading, and in post-reading. Similarly, Kurt (2010) analyzed factors affecting achievement in literacy of eighth grade middle school instrumental music students, including factors such as socioeconomic status (SES), gender, and grade point average (GPA). Results indicated an association between students' literacy achievement and participation in instrumental music. Kurt also found indicators that participating in music instruction may impact cognitive functions that influence other disciplines.

Music facilitates literacy learning, and studies show that verbal memory as well as verbal sequencing improves when a student is involved in a music program (Kurt, 2010). Dreyden found that band participants had statistically higher reading vocabulary and total reading achievement than non-participants, indicating vocabulary and reading ability is improved in those students who receive music instruction (Dreyden, 1992).

Ho et al. (2003) found that music training improves verbal memory. Follow-up research by these researchers found that those students who continued the training continued to improve their verbal memory, while those who discontinued training ceased to improve. Also in the area of verbal development, Piro and Ortiz (2009) found that there are benefits for engaging in musical activities in relation to reading beyond those associated with language development (Piro & Ortiz, 2009). Results of research related to literacy development by Pane and Salmon showed that music facilitates literacy learning (Pane & Salmon 2011). The pairing of linguistic and music intelligences triggers cognitive functions in the brain required for reading and writing (DiEdwardo, 2005).

Music and mathematics.

There is a significant body of research showing a positive relationship between music and mathematics and between the cognitive abilities underlying music and mathematics performance. Whether based on neurological development, that is, aspects of brain stimulation, (Rauscher, Shaw, & Ky, 1993); or through the acquisition of skills linked to music participation (Southgate & Roscigno, 2009), a great deal of research reveals the positive benefits of music instruction for math performance (Zanutto, 1997).

In the early 1990s, Rauscher et al. (1993) conducted groundbreaking research establishing a causal relationship between music instruction and academic achievement, specifically focused on how stimulation of certain parts of the brain corresponds to the relationship between music and mathematics. The work has been termed, "The Mozart Effect." Zanutto (1997) found significant differences in academic achievement between instrumental and non-instrumental students in several core subject areas, including mathematics. Hetland found "confirmatory evidence" that the "Mozart Effect" is strong and consistent between males and females (Hetland, 2000).

Two years later, Bugos and Jacobs (2012) continued on Heltand's path demonstrating a connection between music and mathematics, with research indicating that experiences with musical notational symbols, sequence creation, and compositional concepts positively impact student performance in traditional subjects including math.

One of the more involved studies was a longitudinal study linking music to mathematics achievement conducted by Southgate & Roscigno (2009), who conducted a study involving over

12,000 students, specifically examining the relationship between academic achievement in mathematics and participation in music. The work looked at learning outcomes for 4,376 kindergarten and 1st grade students, in addition to 7,781 high school students in grades 8-12. Their research findings suggest a positive relationship among participation and parent involvement in music and achievement in mathematics for kindergarten and first grade students. For high school students, there was a significant relationship between participation in music and achievement in mathematics.

Research leading to conclusions of a positive relationship between music and math persists. Davenport (2010) found that students who received formal instrumental instruction demonstrated a positive correlation with achievement in algebra, with the findings consistent across variables of race. All students with music instruction performed better in algebra than their counterparts of the same race without music instruction. This analysis supports the theory that music instruction is positively correlated to achievement in mathematics (Helmrich, 2010).

Instrumental music and the achievement gap.

Closing the achievement gap is one of the primary purposes of educational legislation and the accountability movement, particularly NCLB (Editorial Projects in Education, 2011). Research continues to demonstrate arts and music instruction can narrow the achievement gap (Dobb, 2010; Salazar, 2012), defined as “the difference in academic performance between different ethnic groups” (SEDL, 2011). Studies comparing outcomes for students from low vs. high SES backgrounds, and low vs. high participation in arts activities demonstrated that students with high participation in the arts outperformed students with low participation in the arts in a number of areas including academic and civic outcomes (Catterall & Dumais, 2012).

In 2011, the National Endowment for the Arts (NEA) examined the behavior of teenagers and young adults who substantially engaged in the arts (O'Brien, 2012). By nearly every indicator studied, students from a low SES with high-arts education significantly outperformed peers from low-arts, low-SES backgrounds. In many cases, the SES achievement gaps were closed and even eliminated (O'Brien, 2012). Miksza (2007b) conducted a longitudinal study examining correlation between music participation, academic achievement, and socioeconomic status in high school students, finding that students involved in music scored consistently higher on academic achievement tests in math, reading, science, and social studies than students reporting no music participation (Miksza, 2007b).

Music and standardized test scores.

Two common themes emerge from the research relating to music and standardized test scores. The first is that students are not negatively impacted by music instruction, even when they are pulled out of classes in order to receive that instruction (Corral, 1998; Hash, 2011; Holmes, 1997; Miksza, 2007a). The second is that music instruction bears great potential for increasing standardized test scores in students (Dreyden, 1992; Kinney, 2008; McLelland, 2005; Neville, 2008; Trent, 1996).

A significant number of students in the United States receive some part of their music instruction through pullout lessons during the school day, spurring an argument that this practice should be stopped due to the lost instructional time in core classes (Hash, 2011). In the late 1990s Wallick (1998) and Corral (1998) conducted research on this topic. Corral's hypothesis that pullout programs have no negative effect on academic achievement was proven true with no significant difference between the two groups of pullout and non-pullout students (Corral, 1998). Wallick's findings paralleled Corral's. In comparing pullout music students against their ability matched peers on the writing, reading, mathematics, and citizenship parts of the Ohio Proficiency Test (OPT); Wallick found that in reading and citizenship the pullout instrumental music students actually scored statistically higher than the non-instrumental students.

Research has continued to demonstrate that there is no negative effect for pullout instruction on academic outcomes. Hash's (2011) work indicated that band students tended to be more academically successful than non-band students at the outset of their participation (Hash, 2011). Demonstrating similar outcomes, Thornton (2013) compared standardized test scores between voluntary music students and non-music students, showing that those involved in music earned higher scores on state mandated standardized tests than those not involved in music, despite the investment of time required for participation in musical activities.

Overall, the preponderance of research refutes the notion that pullout instrumental music instruction negatively affects any assessment outcomes, and by extension NCLB mandated AYP testing (Wallick, 1998, Gouzouasis, 2007, Hash, 2011, Thornton, 2013). The time that a student dedicates to participation in music instruction does not impede, but rather fosters academic achievement in other 'core' subject areas (Gouzouasis, 2007).

> Many administrators, teachers, and parents assume that providing instruction through pullouts will cause a decline in scholastic performance due to missed class time. Research, however, has found no significant difference between the academic achievement of students who left class for instrumental study, and those who did not, regardless of school size and student background. (Hash, 2011, p.1)

The Scholastic Aptitude Test (SAT) is a test utilized by many colleges and universities as a part of the admissions decision process (Pederson, 2007). Positive correlations have been found between music instruction and SAT scores in a number of cases.

Table 1 (p. 27) shows data reported by the Texas Music Educators Association (2014) relating to band members' SAT scores compared against state and national averages (Texas Music

Educators Association, 2014). A significant question was whether the improvement in testing was due to instrumental music specifically, or to music instruction in general (choral and band). Kinney (2008) studied choral and band participation in an urban middle school, analyzing scores in reading, math, citizenship, and Science. Kinney found students who participated in band showed significant improvement in achievement. Choral participation did not show similar results.

Is it the music that makes the difference?

Not all research is as strongly suggestive relating to the impact of music instruction on closing the achievement gap as Salazar's work in Pinellas County, Florida, or the findings of the National Education Association 2011 report. Studies by Fitzpatrick (2006), Gillmeister (2008), Hash (2011), and Elpus (2013) were inconclusive and suggested that there may not be a correlation. Their work indicated that students who participated in music programs may have been high academic achievers before they entered the music program, suggesting that students enrolled in these programs would have scored well on standardized tests whether they were in music programs or not. In addition, existing research relating to music and academic achievement focuses largely on younger students (Bugaj, 2011, Costa-Giomi, 1999), public school students (Kinney, 2008; Salazar, 2012), or on music in general; not instrumental music specifically (Catterall, 2012). Also, few studies span a significant treatment period of 5 years, as is the case in this work.

Summary.

"Despite the strong supporting evidence, the arts remain on the fringe of education. Music classes are often the last to be added and first to be dropped in hard economic times" (Judson, 2012, p.8). As the President's Committee on the Arts and the Humanities concluded in their 2011 report, "Reinvesting in Arts Education", the educational system's narrow focus on teaching the basics has not been the answer for a large proportion of American students. Many graduates do not possess the skills essential for achieving success in post-secondary education and beyond as they migrate to the work force. (President's Committee on the Arts and the Humanities, 2011).

Catterall and Dumais's work (2012) reinforced the President's Committee's findings, by revealing that students from arts backgrounds, from both low and high socioeconomic strata, are more likely to choose professional majors in college. Art and music instruction should be viewed as complementary to student achievement on standardized tests, rather than a hindrance. Students actively involved in music are more likely than their non-participant peers to achieve success in the academic environment and society (New Jersey Education, 2011). Educational policymakers could leverage the benefits of music instruction, particularly for disadvantaged students by developing instrumental music programs that support low budget schools and "at risk" students (Guisbond, Neill, & Schaeffer, 2012). Instrumental music may serve to help students who border on dropping out of school (Barry, Taylor, Wallis, & Wood, 1990).

United States Secretary of Education Arne Duncan recently stated, "Education in the arts is more important than ever. In the global economy, creativity is essential. Today's workers need more than just skills and knowledge to be productive and innovative participants" (Judson, 2012, p.1). Instrumental music instruction may prove itself to be an effective and valuable weapon in the battle to reduce and eventually eliminate the educational achievement gap, which increasingly prevents countless American students from living up to their potential (Thomas, 2011).

This study serves as a tool to enlighten educational policy makers, highlighting the potential for instrumental music to serve American students as an instructional tool with a possibility for positively affecting student achievement. It studies the impact of instrumental music participation on academic achievement of 8^{th}-12^{th} graders measured by standardized test scores. The methodology, as described below, attempts to address selection bias in this quasi-experimental study, and utilizes regression analysis in order to identify the relationship between instrumental music and standardized test scores in reading and math on the SAT-10 and PSAT.

Methodology

Propensity score matching (PSM) was utilized in an effort to account for selection bias. In this study, the variable of interest is participation in band. PSM provides the conditional probability of participation in the treatment, which is then used to form matched groups of treated and untreated participants who share a similar value of the conditional propensity score. The distribution of observed baseline covariates will be similar between treated and untreated subjects, conditional on the propensity score (Austin, 2011). The PSM can be estimated via a linear or non-linear (probit or logistic) regression. The dependent variable is a categorical variable indicating whether or not a student participates in band (band). The independent variables are gender, ethnicity, standardized test score, and subject grade. (Austin, 2011; Rosenbaum & Rubin, 1983).

Observed characteristics of students prior to their participation in band were utilized to develop the propensity match in this study (Table 2).

Table 2

Variables Included in the Propensity Score Match in Part 1

b_1: SAT-10 Total Reading Score	
For current 8^{th} grade	SAT-10 from 2007-2008 (when they were in 2^{nd} grade)
For current 9^{th} grade	SAT-10 from 2008-2009 (when they were in 4^{th} grade)
For current 10^{th} grade	SAT-10 from 2007-2008 (when they were in 4^{th} grade)
For current 11^{th} grade	SAT-10 from 2008-2009 (when they were in 6^{th} grade)
For current 12^{th} grade	SAT-10 from 2007-2008 (when they were in 6^{th} grade)
b_2: SAT-10 Total Math Score	
For current 8^{th} grade	SAT-10 from 2007-2008 (when they were in 2^{nd} grade)
For current 9^{th} grade	SAT-10 from 2008-2009 (when they were in 4^{th} grade)
For current 10^{th} grade	SAT-10 from 2007-2008 (when they were in 4^{th} grade)
For current 11^{th} grade	SAT-10 from 2008-2009 (when they were in 6^{th} grade)
For current 12^{th} grade	SAT-10 from 2007-2008 (when they were in 6^{th} grade)

b_3: SAT-10 Listening Score	
For current 8th grade	SAT-10 from 2007-2008 (when they were in 2nd grade)
For current 9th grade	SAT-10 from 2008-2009 (when they were in 4th grade)
For current 10th grade	SAT-10 from 2007-2008 (when they were in 4th grade)
For current 11th grade	SAT-10 from 2008-2009 (when they were in 6th grade)
For current 12th grade	SAT-10 from 2007-2008 (when they were in 6th grade)
b_4: Language Arts course grade from 2008-2009	
For current 8th grade	LA from 2008-2009 (when they were in 3rd grade)
For current 9th grade	LA from 2008-2009 (when they were in 4th grade)
For current 10th grade	LA from 2008-2009 (when they were in 5th grade)
For current 11th grade	LA from 2008-2009 (when they were in 6th grade)
For current 12th grade	LA from 2008-2009 (when they were in 7th grade)
b_5: Math course grade from 2008-2009	
For current 8th grade	Math from 2008-2009 (when they were in 3rd grade)
For current 9th grade	Math from 2008-2009 (when they were in 4th grade)
For current 10th grade	Math from 2008-2009 (when they were in 5th grade)
For current 11th grade	Math from 2008-2009 (when they were in 6th grade)
For current 12th grade	Math from 2008-2009 (when they were in 7th grade)
b_6: Art course grade from 2008-2009	
For current 8th grade	Math from 2008-2009 (when they were in 3rd grade)
For current 9th grade	Math from 2008-2009 (when they were in 4th grade)
For current 10th grade	Math from 2008-2009 (when they were in 5th grade)
For current 11th grade	Math from 2008-2009 (when they were in 6th grade)
For current 12th grade	Math from 2008-2009 (when they were in 7th grade)
b_7: Chorus course grade from 2008-2009	
For current 8th grade	Math from 2008-2009 (when they were in 3rd grade)
For current 9th grade	Math from 2008-2009 (when they were in 4th grade)
For current 10th grade	Math from 2008-2009 (when they were in 5th grade)
For current 11th grade	Math from 2008-2009 (when they were in 6th grade)
For current 12th grade	Math from 2007-2008 (when they were in 6th grade)
b_8: Ethnicity	
b_9: Gender	

Observed characteristics utilized to develop the propensity match in this study include standardized test scores in subject areas frequently identified in literature as linked to music (language arts, reading, and math) as well as subjects in school with characteristics closely related to instrumental music (art and chorus) as well as two frequently identified categorical characteristics (gender and ethnicity).

There were intermediary steps before moving on to Part 2. An important step in Part 1 was to establish or determine how the matching (of the comparison or counterfactual to the treated group) would be conducted. Some of the most widely used methods of matching include, among others, one-to-one matching, k-nearest neighbor matching, radius matching, kernel matching, matching with or without replacement, and stratified matching. This study considered a variety of matching methods to investigate the sensitivity of the results, where possible given the sample size and ultimately implemented the most-widely used method, one-to-one matching. One-to-one matching involves forming pairs of treated and untreated participants in such a way that matched participants have similar values of the propensity score. Some of the diagnostic techniques used include visual analysis of histograms of the propensity distribution or testing difference between mean propensity scores or standardized differences.

For the purposes of developing the propensity score match and for comparison of the identified comparison and treatment groups, academic grade, gender, and ethnicity data came from historical school records maintained digitally in Blackbaud school record keeping software. Blackbaud provides school recordkeeping software products for over 3,000 independent schools. Specifically, the information for this study was kept in Blackbaud's Education Edge "module" (www.blackbaud.com). At the studied school, all student data, including standardized test scores and grades for each class taken, are input and permanently stored in their individual database record managed within Blackbaud. The data for this study was retrieved from Education Edge, or from the paper copies of the standardized tests themselves in cases where the data had not yet been entered into the Education Edge system. Standardized test score results for the same purposes came from electronic and paper records maintained by the school. The standardized test score results came from three sources. The Stanford Achievement Test version 10 (SAT-10), which includes assessments in reading and math, is typically administered annually to all students in grades 4, 6, and 8. The Preliminary Scholastic Aptitude Test (PSAT), including assessments in reading and math, is annually administered to students in 9^{th} – 11^{th} grades. Finally, the

Scholastic Aptitude Test (SAT), which includes assessments in reading and math, is annually administered to students in the 11th and 12th grades. All three are national norm-referenced standardized tests.

The schedule of testing has varied at the school over the years, depending on the available testing budget. The school targets areas of instructional improvement using the SAT-10 test. In the 9th and 10th grades, the PSAT is considered a preparation for the 11th grade administration, because the test's publisher, the College Board, uses 11th grade PSAT scores to determine eligibility for National Merit recognition. Students in 12th grade take the SAT as a vehicle to assist in the process of college admission.

The SAT and American College Testing (ACT) are the two primary standardized tests used by the vast majority of colleges in the United States for admissions screening (Strauss, 2012). The SAT was chosen over the ACT for this study because the SAT is norm-referenced like the SAT-10 and PSAT. The ACT is standards referenced. In addition, 95% of seniors at the school typically take the SAT, with ACT participation only approaching 60%.

The norm-referenced SAT-10, PSAT, and SAT allow comparison of students over the years, because in each year of test administration, the tests compare students to peers taking the test nationally (norm-referencing), a population remaining consistent as students advance through school and continue to participate in testing over time. The researcher used equipercentile linking to establish equivalent scores and standard score scaling to establish a continuous variable common to the reading scores from each of the different tests utilized in the study, and common to the math scores from the different tests utilized. The standard scale score ranged from 50 to 150, with a mean of 100 and a standard deviation of 10. Two fundamental assumptions required for equipercentile linking are that the tests are similarly normed, and that they are measuring the same constructs. In this case, equipercentile linking can be used because the tests assess the same constructs. The reading instruments were assumed to measure similar constructs and to be normed on similar samples. Likewise, the math instruments were assumed to measure similar constructs and to be normed on similar samples.

Part 2 involved two sets of 3 linear regressions using reading and math scores from the reading section of the SAT-10, the critical reading section of the PSAT, the SAT-10 math section score, and PSAT math section scores administered in the 2013-2014 academic year. This regression analysis was completed using students arising from the propensity matching of 4 cohorts in Part 1, a total of 80 matching students. For the six regression equations utilized in part 2:

Outcome variable = Yi,	Attendance estimate = B3,
Intercept = B0,	Days attended for student i =Attendi,
Treatment estimate = B1,	Discipline estimate = B4,
Treatment indicator = Bandi,	Discipline value for student i = Disciplinei,
Propensity score estimate = B2,	Error term for each student = ei.
Measured propensity score = Pscorei,	

Figure 1: Variable Names

Of the six regressions conducted, three established the relationship between band and reading test scores, and three established the relationship between band and math test scores. The first two regressions included band membership as the treatment indicator on standardized test scores in reading and math ($Y_i = B_0 + B_1 Band_i + e_i$). The second pair of regressions controlled for the propensity score, with band membership as the treatment indicator on standardized test scores in reading and math ($Y_i = B_0 + B_1 Band_i + B_2 Pscore_i + e_i$). The third and final set of two regressions controlled for the propensity score, absences, and conduct with band membership as the treatment indicator on standardized test scores in reading and math ($Y_i = B_0 + B_1 Band_i + B_2 Pscore_i + B_3 Attend_i + B_4 Discipline_i + e_i$).

Procedures.

Part 1 of the study identified comparison and treatment groups using a propensity score match. There were a total of 206 students with complete data prior to the propensity matching process categorized as 56 band and 150 non-band. Students were stratified into grade level cohorts for matching purposes, with propensity matching conducted for the classes of 2014, 2015, 2016, 2017, and 2018. The data utilized to develop the propensity score equation (1) was gathered from the year prior to implementation of the band program (2008-2009), with a few exceptions as necessary due to limitations in the availability of data (identified in Table 1). The propensity score match was utilized to model factors leading to student selection of participation in band. Propensity score matching methodology allows one to estimate the probability of student participation in band. This provided an opportunity to create comparison and treatment groups with similar propensities for choosing band. Ideally, this addressed the obstacle of selection bias. Once the appropriate comparison and treatment groups were created, this study estimated the proposed specifications described above with the treatment group including only those students who participated in band. Table 3 below summarizes the specification strategy.

Table 3

Study Model

Pre-Treatment to Post Treatment Comparisons (Reading and Math Test Scores)
Comparison and Treatment Groups Identified Using Propensity Score Match

Part 1: Propensity score match
The propensity score process used logistic regression and the nearest neighbor algorithm with a caliper set at 0.2 and matching without replacement.

Dependent variable: Categorical variable indicating whether or not student is in band

Independent variables: gender, ethnicity, standardized test scores, subject grades

The sample included 206 students in 8th – 12th grade who attended the school for the entire 5 years of the band program's existence. The probabilities estimated from Part 1 were used to create comparison and treatment groups of band and non-band participants to be used in Part 2.

A stratified PSM was completed for students in each grade, leaving 80 students for Part 2 of the study; 33 band (treatment) and 47 non-band (comparison)

Part 2: Linear Regression

Part 2 involved three models of multiple linear regressions to determine the extent and direction of the influence of band membership on reading and math scores with band membership as the treatment indicator in model 1, controlling for the propensity score in model 2, and controlling for the propensity score, attendance, and disciplinary infractions in the third model. Each of the three models was run on reading scores and each of the three was run on math scores.

Dependent variable: Student test scores (reading and math)

Independent variables: Categorical variables indicating band and non-band participation, propensity score, and attendance and discipline.

- Part 2 utilized SAT-10 scores for 8th grade, and PSAT scores for 9th -11th grade students in band (treatment) vs. comparison group. The propensity scores were only used in the matching process, so when the 12th grade was eliminated, the researcher chose to use the students identified in the PSM and run the regression on them, excluding the 12th grade from Part 2 of the study.

The comparison and treatment groups were selected utilizing a propensity score match as determined in Part 1. The treatment group includes students who participated in band. The comparison group includes those who did not participate in band.

*The SAT-10, PSAT, and SAT are norm-referenced tests, designed to compare student performance against other students across the country at the same grade level under similar testing conditions.

The study compared test scores of students from a cohort of 206 students – a subgroup of all students enrolled in the school in 2013-2014 in grades 8-12. The 206 students in the cohort were 8-12th graders who attended the school for a minimum of 5 years, since 2009-2010 or before when these students were in grades 4-8. The 2009-2010 academic year was the first time a band program was offered, available for all students in grades 4 through 12. This study compared student performance on standardized tests in 2013-2014 between band and non-band participants. The treatment is participation in band.

It was hypothesized that students who participated in band (treatment group) would have higher standardized test scores in reading and math than the non-participant comparison group (assigned by the propensity score match). Sources of data for the comparison in Part 2 of the study of band and non-band groups are reflected in Table 4.

Table 4

Sources of Comparison Data for Part 2

Class of 2018	SAT-10 Reading and Math scores from 2013-2014
Class of 2017	PSAT Reading and Math scores from 2013-2014
Class of 2016	PSAT Reading and Math scores from 2013-2014
Class of 2015	PSAT Reading and Math scores from 2013-2014
Class of 2014	SAT Reading and Math scores from 2013-2014

In the second part of the study, two sets of three regressions were conducted to determine the extent and direction of influence band membership has on the reading and math standards, for a total of 6 multiple linear regressions.

- Model 1 included band membership as the treatment indicator,
- Model 2 controlled for the propensity score with band membership as the treatment indicator,
- Model 3 controlled for the propensity score, absences, and conduct, with band membership as the treatment indicator.

In the first three models, the dependent variable was the standardized reading score. In the second three models, the dependent variable was the standardized math score.

The propensity score match from Part 1 identified students not in band, but possessing characteristics similar to those in band, most notably similar test scores and grades in specific academic courses, tested areas, and in music and arts classes prior to treatment. Covariates selected for PSM should be those believed to, "influence simultaneously the participation decision and the outcome variable" (Caliendo & Kopienig, p.6, 2008). Covariates were selected for this study due to their influence on a student's potential participation in band. Measurement utilized outcomes of standardized testing, depending on the grade of the student. The hypothesis was tested to determine if there is statistical evidence to support the claim that students in band perform better on standardized tests in reading and math than students who did not participate.

The study started with 206 band and non-band students who had been enrolled at the school for 5 years or more (since the inception of the band program) for whom data existed to perform the PSM. A stratified propensity match was conducted within each individual cohort; the classes of 2014 through 2018. The stratified PSM led to a reduction from the original 206 students to 80 remaining matched students (Table 6). Band students were matched using propensity scores with students in the same school who do not participate in band. The covariates used to match the groups using propensity scoring were: gender, ethnicity, reading score prior to band, math score prior to band, listening score prior to band, language arts, math, art and chorus class grades prior to band. The gender and ethnicity variables were categorical and the remaining seven covariates were Stanford Achievement Test (SAT-10) percentiles for reading, math, and listening from the 2007-2008 administration of the tests and the language arts, math, art, and chorus classroom grades for 2008-2009 for all students. Test percentiles and classroom grades were recorded prior to membership in band for all students, and were used as covariates for the propensity score matching process.

The propensity score process used logistic regression and the nearest neighbor algorithm with a caliper set at 0.2 and matching without replacement. No students were matched in the class of 2014, 6 in the class of 2015, 23 in the class of 2016, and 25 in the class of 2017. These 80 students, 33 band and 47 non-band, were then used in Part 2 of the study.

Data.

There were approximately 206, 8th – 12th grade students attending the private K-12 Catholic school in the suburbs of Atlanta included and analyzed in this study. All students included in the cohort for research attended the school for at least 5 years. The band program at the school began in the 2009-2010 academic year. Students in the treatment group study had an average dosage of >4 years in band. Data was recorded for students in the graduating classes of 2014, 2015, 2016, 2017, and 2018. All students from the aforementioned classes who had been enrolled in the 2009-2010 academic year (when the band program was started) or earlier were listed in a spreadsheet, capturing the data collected for each student, then assigned an encoded number to protect their identity. Once the students were de-identified, statistical comparisons were conducted on the groups as a whole.

Table 5

Student Data by Grade Level

Grade (2013-2014)	Enrolled (8-12th) 2013-2014	Females/Males	Enrolled in 2009 or earlier	Females/ Males
Class of 2018	73	39/34	40	19/21
Class of 2017	82	37/45	41	18/23
Class of 2016	73	36/37	48	24/24
Class of 2015	66	37/29	42	23/19
Class of 2014	55	27/28	35	18/17
Total	**349**	**176/173**	**206**	**102/104**

The result of the propensity matching in each of the grade levels produced the data included in Table 6.

Table 6

Results of Stratified Propensity Score Matching from Part 1

Class	Prior to Propensity Match			After Propensity Match		
	Band	Non-Band	Total	Band	Non-Band	Total
2014	3	34	37	0	0	0
2015	5	35	40	2	4	6
2016	9	40	49	8	15	23
2017	20	20	40	10	15	25
2018	19	21	40	13	13	26
Total	56	150	206	33	47	80

Details of the specific cohort propensity matching are shown in the following figures for each cohort. To assure a more balanced match, the students were stratified into grade level cohorts for matching purposes, and the propensity matching was conducted by cohort at the following grade levels: Class of 2014, 2015, 2016, 2017, and 2018. The propensity score distributions in Figures 1-4 indicate the one-to-many matching of the propensity score function and the elimination of those students with differing propensity scores on the selected covariates.

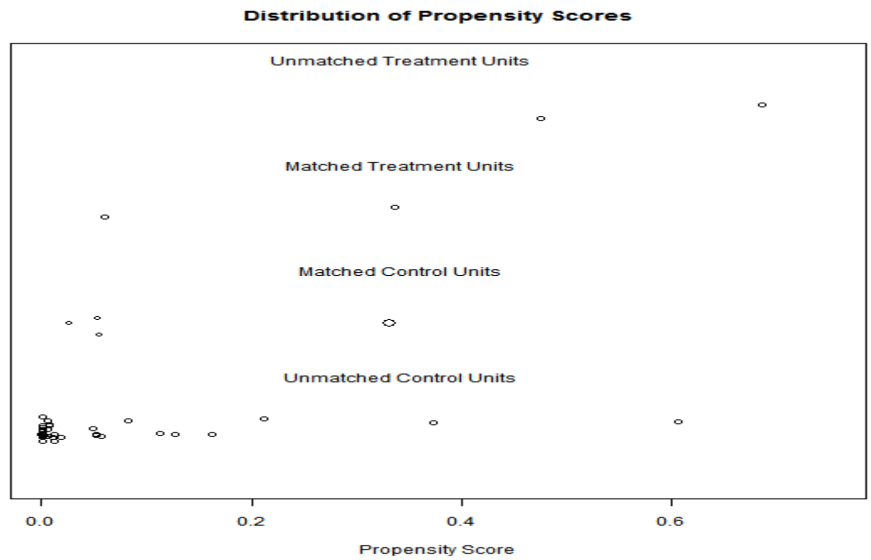

Figure 2. Cohort Class of 2015 Propensity Score Distribution

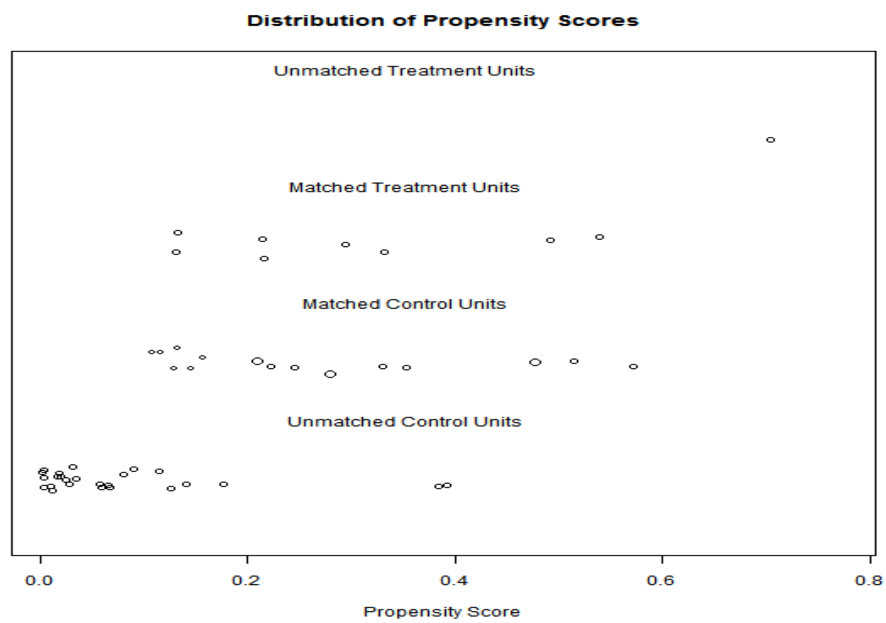

Figure 3. Cohort Class of 2016 Propensity Score Distribution

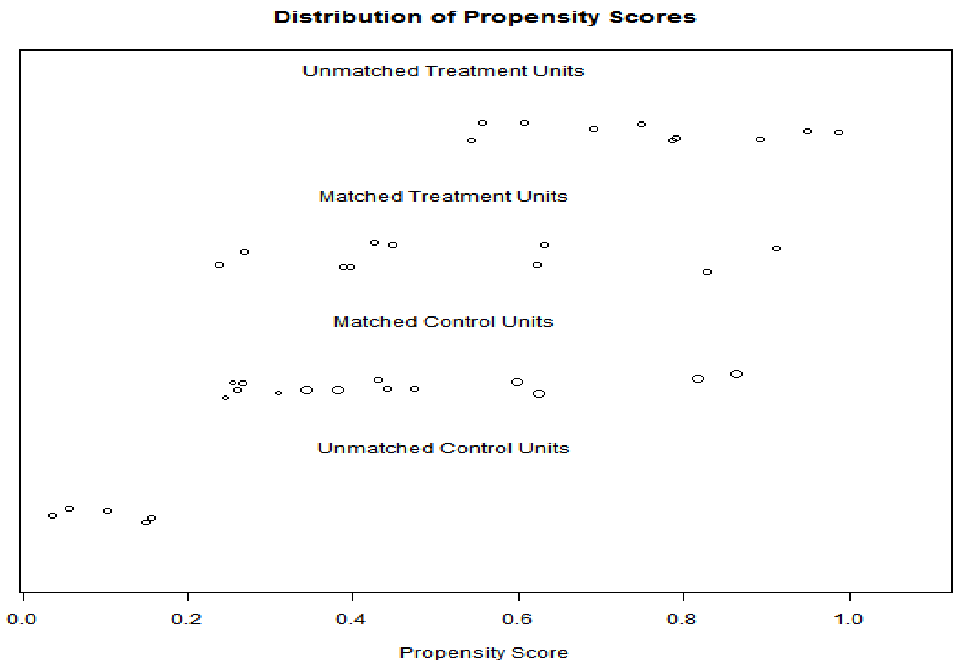

Figure 4. Cohort Class of 2017 Propensity Score Distribution

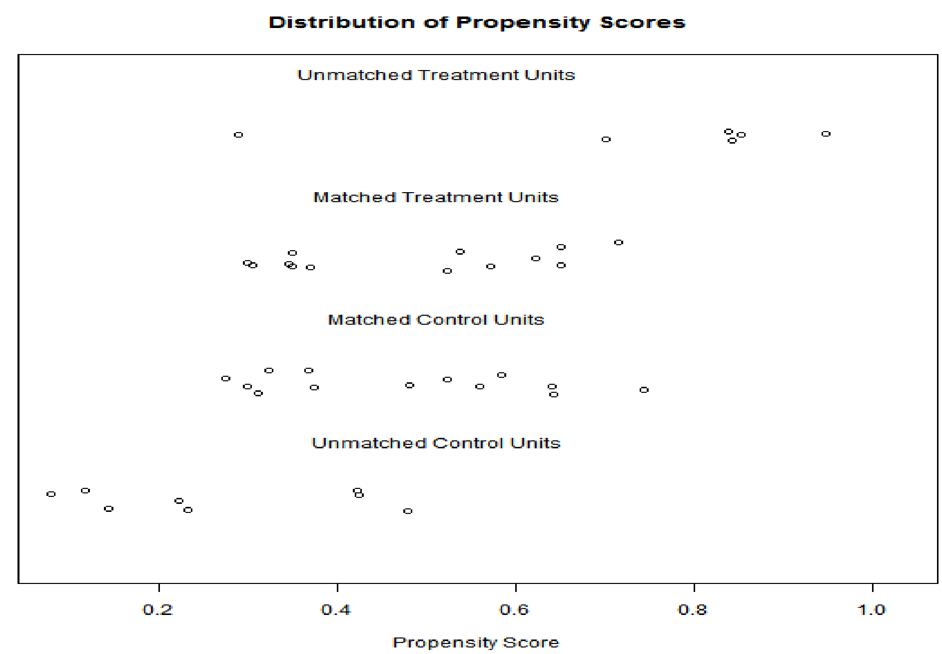

Figure 5. Cohort Class of 2018 Propensity Score Distribution

Both treatment and comparison students who did not fall within the caliper match (0.2 of a standard deviation) of the propensity-scoring program were excluded from the final matched set of students. In total, 80 students were matched using propensity scores across 4 of the 5 originally considered cohorts (Figures 1-4).

Propensity score matching in the study was accomplished using Propensity Score Matching for SPSS software (version 3). It is an SPSS dialogue programmed by Thoemmes and Liao that works with existing R packages for propensity scoring. The propensity score process used logistic regression and the nearest neighbor algorithm with a caliper set at 0.2 and matching without replacement.

Table 7

Test Means Before and After PSM: All Students vs. Band Students

	Mean Score
Before PSM	
Pretreatment Reading – Non-Band Students	78.87
Pretreatment Reading - Band Students Only	77.13
Difference	1.74
Pretreatment Math – Non-Band Students	83.08
Pretreatment Math – Band Students Only	81.59
Difference	1.49
After PSM	
Pretreatment Reading – Non-Band Students	78.32
Pretreatment Reading – Band Students Only	76.45
Difference	1.87
Pretreatment Math – Non-Band Students	83.11
Pretreatment Math – Band Students Only	83.64
Difference	-0.53

Table 7 shows the mean test scores for reading and math before and after the PSM for non-band students, compared to band students only. In the case of reading scores, the difference in the mean score between non-band students and band students before the PSM was 1.74. After the PSM, the difference was 1.87. For math scores, the difference in the mean score between non-band students and band students before the PSM was 1.87. After the PSM, the difference was reduced to 0.53. The PSM reduced the overall difference in the mean scores between non-band students and the students who participated in band. As would be expected, the use of PSM had the overall effect of making the groups used for analysis more similar, allowing for a more accurate estimate of the effect of the treatment.

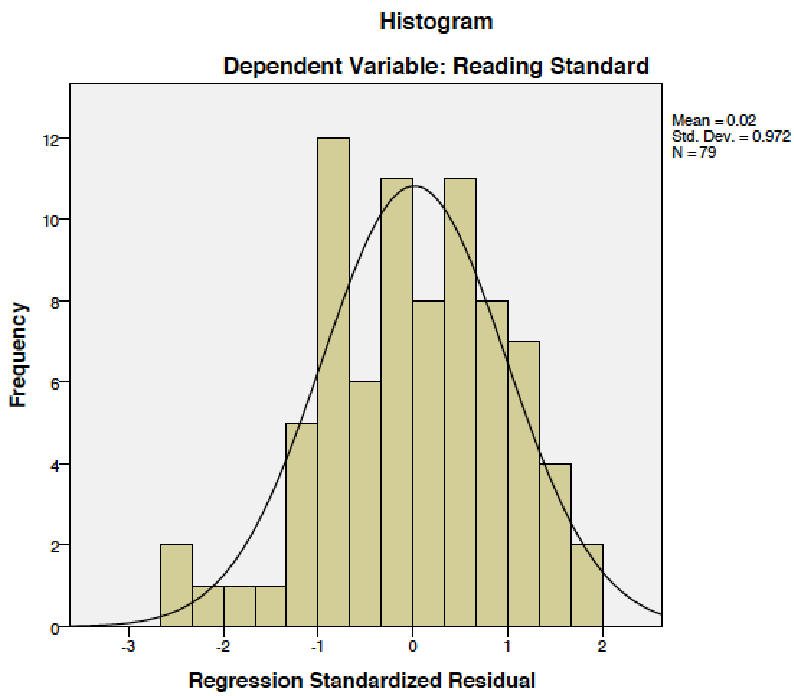

Figure 5. Histogram of the Dependent Variable: Reading Standard

One of the assumptions of using simple linear regression is that the dependent variable is normally distributed. That assumption is met as indicated by the histogram in Figure 5.

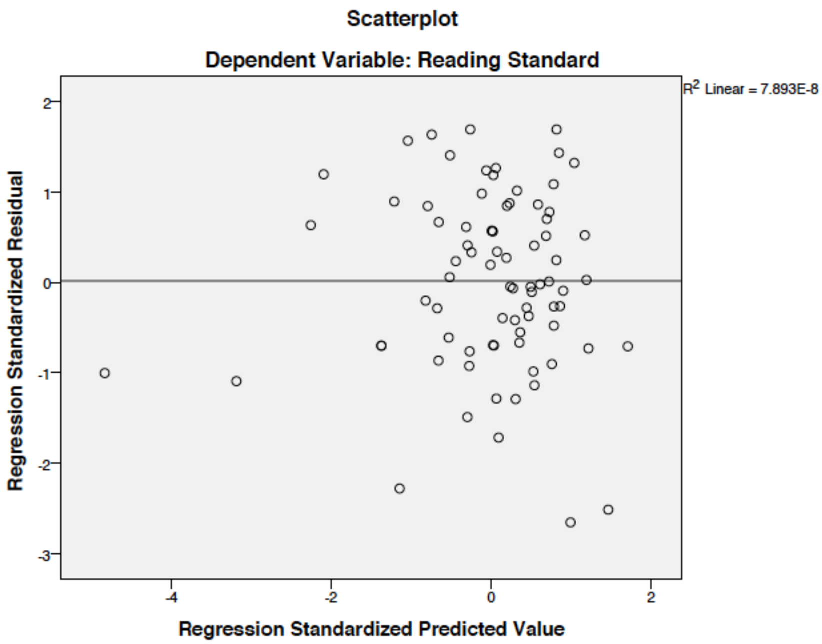

Figure 7. Scatterplot: Reading Standard

Figure 6 shows that with the reading standard, the assumptions of using the regression model are tenable if the residuals plotted against the predicted values scatter about a 0 line (Lesson 1, 2015). The dichotomous variable, band or non-band residuals and predicted values lie approximately equally below and above the 0 line, indicating a correct model for regression by demonstrating homoscedasticity, an assumption central to linear regression models. Homoscedasticity shows a situation where the error term or random disturbance in the relationship between the independent variables and the dependent variable is similar across all values of the independent variables (Statistics Solutions, 2013).

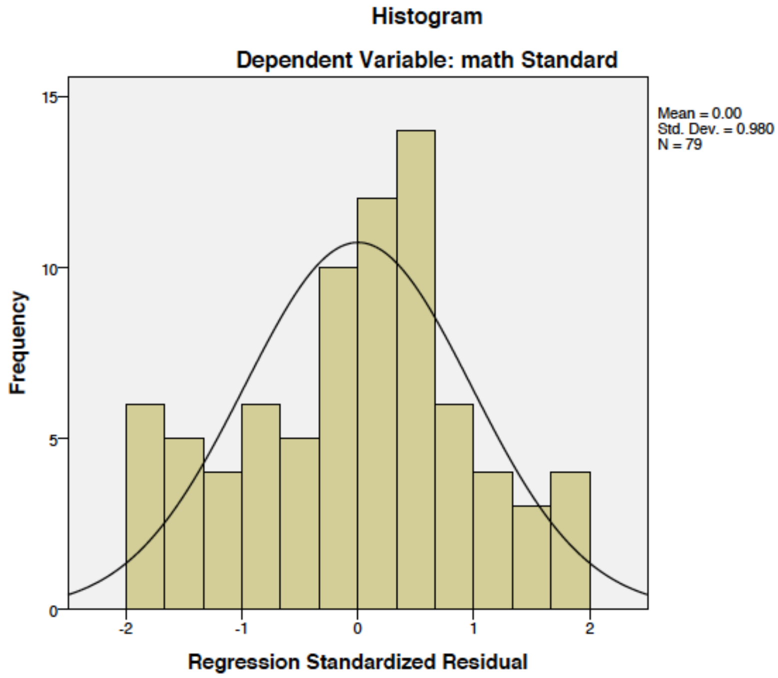

Figure 8. Histogram of the Dependent Variable: Math Standard

One of the basic assumptions of using simple linear regression is that the dependent variable is normally distributed. That assumption is met as indicated by the histogram in Figure 7.

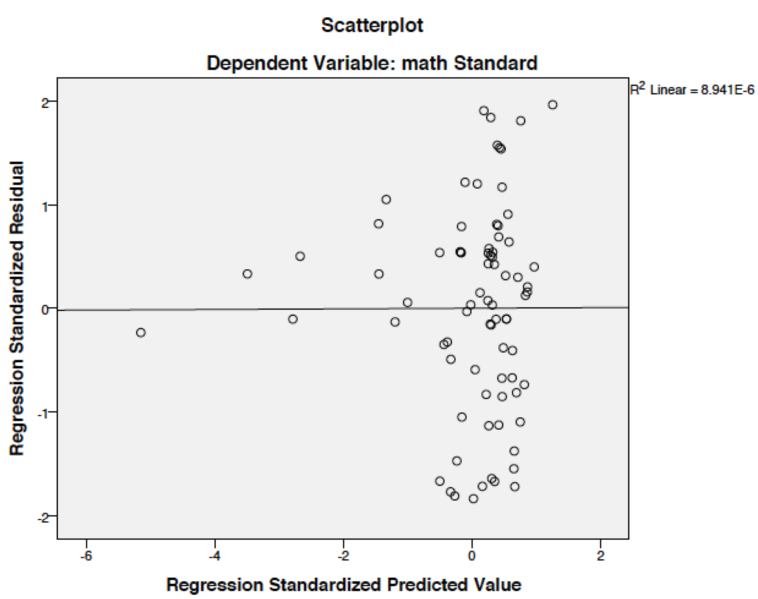

Figure 9. Scatterplot: Math Standard

As with the reading standard, the assumptions of using the regression model for the math standard are tenable if the residuals plotted against the predicted values scatter about a 0 line (Lesson 1, 2015). Figure 8 shows that the dichotomous variable, band or non-band residuals and predicted values lie approximately equally below and above the 0 line, indicating a correct model for regression demonstrating homoscedasticity, an assumption that is central to linear regression models. As with reading, homoscedasticity shows a situation where the error term or random disturbance in the relationship between the independent variables and the dependent variable is similar across all values of the independent variables (Statistics Solutions, 2013).

Results

The Part 2 analysis of the total group of 80 matched students from Part 1 indicated if band membership had a statistically significant influence on standardized reading and math scores. The research failed to reject the null hypothesis of the study that the test means of band participation are not greater than the test means in reading and math of the comparison group. The findings of this study are not generalizable to all populations, but are limited to students included in this specific set of independent Catholic school students in the sample. The unique socio-economic and racial circumstances of the studied population provide interesting and potentially useful findings relating to possibilities for music instruction to enhance learning.

Table 8

Descriptive Statistics for Part 2 Reading Regression Models

Descriptive Statistics

	Mean	Std. Deviation	N
Reading Standard	108.554	11.7687	80
Band or Not	.41	.495	80
Propensity Score	.41250	.100461	80
Absences	5.66	4.579	79
Conduct	2.30	3.953	79

Table 8 shows the means and standard deviations for the independent and dependent variables included in the first set of three regressions for reading.

Table 9

Coefficients for Part 2 Reading Regression Models

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	107.633	1.731		62.179	.000
	Band or Not	2.232	2.695	.094	.828	.410
2	(Constant)	116.086	5.586		20.783	.000
	Band or Not	3.116	2.726	.131	1.143	.257
	Propensity Score	-21.376	13.444	-.182	-1.590	.116
3	(Constant)	122.894	5.395		22.779	.000
	Band or Not	2.106	2.434	.089	.865	.390
	Propensity Score	-30.354	12.103	-.259	-2.508	.014
	Absences	.110	.258	.043	.427	.671
	Conduct	-1.438	.305	-.483	-4.714	.000

a. Dependent Variable: Reading Standard

In Table 9 we can see from the unstandardized coefficients in all three models that the treatment (band membership) has no meaningful relationship to standardized reading scores. In model 1, band is not a statistically significant predictor of the reading score with a coefficient of 2.232. In model 2, where the propensity score is introduced as a control, the coefficient for band is larger at 3.116, but is still not statistically significant. In model 3, adding conduct and attendance to the controls, the coefficient for band is 2.106; also not statistically significant.

A possible explanation for why conduct is a predictor of reading score while attendance is not may be school policy. The school assigns zero grades and does not allow work to be made up when a student is suspended as a result of disciplinary action which may have a negative impact on student reading and math scores. Conversely, the school provides a generous amount of time and flexibility to make up missed work when a student's absence is excused.

Table 10

Descriptive Statistics for Part 2 Math Regression Models

Descriptive Statistics

	Mean	Std. Deviation	N
math Standard	108.777	11.2568	80
Band or Not	.41	.495	80
Propensity Score	.41250	.100461	80
Absences	5.66	4.579	79
Conduct	2.30	3.953	79

Table 10 shows the means and standard deviations for the independent and dependent variables included in the first set of three regressions for math.

Table 11

Coefficients for Part 2 Math Regression Models

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	107.154	1.638		65.419	.000
	Band or Not	3.934	2.550	.173	1.542	.127
2	(Constant)	99.325	5.289		18.779	.000
	Band or Not	3.115	2.582	.137	1.207	.231
	Propensity Score	19.798	12.730	.177	1.555	.124
3	(Constant)	107.340	5.076		21.145	.000
	Band or Not	2.258	2.290	.099	.986	.327
	Propensity Score	11.003	11.388	.098	.966	.337
	Absences	-.165	.243	-.067	-.677	.500
	Conduct	-1.347	.287	-.473	-4.691	.000

a. Dependent Variable: math Standard

In Table 11 we can see from the unstandardized coefficients in all three models that the treatment (band membership) has no meaningful relationship to standardized math scores. In the first model, band is not a statistically significant predictor of the math score with a coefficient of 3.934 ($t = 1.542$, $p = .127$). In model 2, where the propensity score is introduced as a control, the coefficient for band is smaller at 3.115 ($t = 1.207$, $p = .231$), but is still not statistically significant. In model 3, adding conduct and attendance to the controls, the coefficient for band is 2.258 ($t = .986$, $p = .327$) which is also not statistically significant.

A possible explanation for why conduct is a predictor of math score while attendance is not may be school policy; the same situation as previously described for reading.

Discussion

The research failed to reject the null hypothesis of the study. The findings of this study are not generalizable to all populations. The unique socio-economic and racial circumstances of the studied population provide interesting and potentially useful findings relating to the possibilities for music instruction to enhance learning.

Though the literature review revealed numerous studies supporting the hypothesis, the failure to find statistically significant results when considering the possible selection bias issue specifically addressed in this work is not unprecedented. One example is research published in the Journal of Research in Music Education in July, 2013 that examined college entrance exam scores of music and non-music students in the United States. While the study did not address instrumental music specifically, it did look at the 36.38% of the class of 2004 (1.127 million students) who graduated high school with at least one course credit in music. The study used fixed-effects regression to compare test scores of music and non-music students while controlling for variables relating to demography, academic achievement, time use, and attitude. As in this study, results indicated music students did not significantly outperform non-music students once these systematic differences had been statistically controlled (Elpus, 2013).

This study did not reveal a statistically significant relationship between participation in the instrumental music program and higher standardized test scores in reading and math. However, work by Southgate and Roscigno (2009), Dreyden (1992), Ho, Cheung, and Chan (2003), and others repeatedly identified the existence of positive associations between music and achievement in school, often revealing connections to both mathematics and reading achievement (Southgate & Roscigno, 2009).

This work did reveal similar outcomes in the reading and math measurements of the SAT-10 and PSAT, though not statistically significant. One possible explanation for the findings is that this work involved a different population of student than those encountered in most existing research. The students in this study were from a Catholic school, primarily in the upper-middle to upper class socio economic range. This was likely an influencing factor on the research. The homogeneous SES of the students studied suggests that most parents of the comparison and treatment groups have the resources available to remediate with tutoring or supplemental learning opportunities when their children struggle academically.

The failure to reject the null hypothesis demonstrates a lack of statistical significance of the higher averages of instrumental over non-instrumental students. Statistical significance is concerned predominantly with whether a research result is due to chance or sampling variability. However, in recent decades, another form of significance has been increasingly considered in research results. This is practical significance, which is concerned with whether the result of the work is useful in the real world (Kirk, 1996). It could be argued that the average test scores for instrumental students involved in this study, while not statistically significantly higher than those for non-music peers, are practically higher. A larger sample size may have yielded a result more consistent with research indicating a significant relationship between instrumental music and academic achievement does exist (Gadberry, 2010; Hash, 2011; Hollenbeck, 2008; Ruppert, 2006; Salazar, 2012; Southgate & Roscigno, 2009). The possible connection between music and enhanced learning bears great potential for improvements in the American educational system.

Implications.

A major implication of the finding is that instrumental music may be a mechanism bearing potential for enhancing academic outcomes for all students in any type of school, not exclusively minorities or the economically disadvantaged. Catterall & Dumais (2012) found that students with high participation in the arts outperform peers with low participation in both academic and civic outcomes, including long-term outcomes where the largest effect was on students identified as "at risk." Although the enhanced math and reading scores found in this study were not statistically significant, the marginal improvements in test scores demonstrated in the work which exclusively involved students of substantial financial resources does add to existing evidence that music participation may provide more than an otherwise missing "outlet" for students, and may increase actual cognitive development, through the act of participation itself (Baker, 2013).

A second potential implication of this work is that demonstration of a difference in standardized test scores of band participants, albeit not statistically significant, still supports the argument that instrumental music could be used to foster improvements in achievement in students, regardless of SES. Recent work by Baker (2013) strongly indicates that musical training adds new neural connections in the brain, with links established between students with learning disabilities and the ability to improve their ability to learn.

Future research relating to instrumental music and academic achievement could focus on pure experimental research (potentially executed in a case where a mandatory instrumental music program is implemented for an entire school) as opposed to quasi-experimental. Scientifically eliminating selection bias, and focusing on homogeneous groups of students, such as those from families of uniformly low or high SES, could add to the validity of the findings of research suggesting instrumental music does positively impact academic achievement. Convincing educational decision makers of the benefits of instrumental music instruction could benefit many students who are presently underserved, failing to maximize their academic potential.

Conclusion.

The data analysis of this study leads to a conclusion that participation in an instrumental music program does not lead to statistically significant improvement in standardized testing in reading and math for the participants. Even though many studies have linked music to academic achievement, the results of this study do not strongly support many of the other studies on the topic (Baker, 2013; Cole, 2011; Hardiman, et. al, 2009; Jonides, 2008; Neville, 2008; Olson, 2010), showing an impact of music on academic achievement. However, despite the failure to demonstrate a statistically significant difference, the results of this work still do show a difference, with band students scoring higher on standardized tests than their non-band peers.

One possible reason for the failure to demonstrate a statistically significant difference in academic achievement between band and non-band students in the study is the lack of matches within the caliper width used in the PSM, which led to a reduction of power. Another possible explanation is the filtering process of the PSM conducted. Considering that the propensity score match was utilized to model factors leading to student selection of participation in band, it is essential that the variables utilized in the PSM equation actually do so. Failure to do so could lead to an ineffective PSM. "… omitting important variables can seriously increase bias in resulting estimates. Only variables that influence simultaneously the participation decision and the outcome variable should be included" (Caliendo & Kopeinig, p. 6, 2008). It is possible that some of the variables utilized in this study did not meet Caliendo and Kopeinig's standard.

Closing achievement gaps and increasing overall levels of academic achievement, even if pursued solely as a product of an educational system hyper-focused on testing, is an invaluable potential outcome of instrumental instruction. Coupled with the desire for students to learn musical performance for the sake of cultural enrichment, recognition of the value for the contribution of instrumental music instruction in schools by educational leadership becomes a necessity. A failure to do so would result not only in an inability to maximize the learning potential of all students, but an enormous cultural loss that would be felt for generations.

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APPENDICES

Appendix A: Part 2 Regression Results - Reading

Descriptive Statistics

	Mean	Std. Deviation	N
Reading Standard	108.554	11.7687	80
Band or Not	.41	.495	80
Propensity Score	.41250	.100461	80
Absences	5.66	4.579	79
Conduct	2.30	3.953	79

Correlations

		Reading Standard	Band or Not	Propensity Score
Pearson Correlation	Reading Standard	1.000	.094	-.156
	Band or Not	.094	1.000	.204
	Propensity Score	-.156	.204	1.000
	Absences	-.001	.030	-.024
	Conduct	-.442	-.118	-.179
Sig. (1-tailed)	Reading Standard	.	.204	.084
	Band or Not	.204	.	.035
	Propensity Score	.084	.035	.
	Absences	.497	.397	.416
	Conduct	.000	.151	.057
N	Reading Standard	80	80	80
	Band or Not	80	80	80
	Propensity Score	80	80	80
	Absences	79	79	79
	Conduct	79	79	79

Correlations

		Absences	Conduct
Pearson Correlation	Reading Standard	-.001	-.442
	Band or Not	.030	-.118
	Propensity Score	-.024	-.179
	Absences	1.000	.109
	Conduct	.109	1.000
Sig. (1-tailed)	Reading Standard	.497	.000
	Band or Not	.397	.151
	Propensity Score	.416	.057
	Absences	.	.169
	Conduct	.169	.
N	Reading Standard	79	79
	Band or Not	79	79
	Propensity Score	79	79
	Absences	79	79
	Conduct	79	79

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Band or Not[a]	.	Enter
2	Propensity Score	.	Enter
3	Absences, Conduct	.	Enter

a. All requested variables entered.
b. Dependent Variable: Reading Standard

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.094[a]	.009	-.004	11.7925
2	.202[b]	.041	.015	11.6772
3	.512[c]	.262	.222	10.3776

Model Summary[d]

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	.009	.686	1	77	.410
2	.032	2.528	1	76	.116
3	.222	11.113	2	74	.000

a. Predictors: (Constant), Band or Not
b. Predictors: (Constant), Band or Not, Propensity Score
c. Predictors: (Constant), Band or Not, Propensity Score, Absences, Conduct
d. Dependent Variable: Reading Standard

ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	95.377	1	95.377	.686	.410[a]
	Residual	10707.893	77	139.064		
	Total	10803.270	78			
2	Regression	440.098	2	220.049	1.614	.206[b]
	Residual	10363.172	76	136.358		
	Total	10803.270	78			
3	Regression	2833.800	4	708.450	6.578	.000[c]
	Residual	7969.471	74	107.696		
	Total	10803.270	78			

a. Predictors: (Constant), Band or Not
b. Predictors: (Constant), Band or Not, Propensity Score
c. Predictors: (Constant), Band or Not, Propensity Score, Absences, Conduct
d. Dependent Variable: Reading Standard

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	107.633	1.731		62.179	.000
	Band or Not	2.232	2.695	.094	.828	.410
2	(Constant)	116.086	5.586		20.783	.000
	Band or Not	3.116	2.726	.131	1.143	.257
	Propensity Score	-21.376	13.444	-.182	-1.590	.116
3	(Constant)	122.894	5.395		22.779	.000
	Band or Not	2.106	2.434	.089	.865	.390
	Propensity Score	-30.354	12.103	-.259	-2.508	.014
	Absences	.110	.258	.043	.427	.671
	Conduct	-1.438	.305	-.483	-4.714	.000

a. Dependent Variable: Reading Standard

Excluded Variables[c]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Propensity Score	-.182[a]	-1.590	.116	-.179	.958
	Absences	-.004[a]	-.032	.974	-.004	.999
	Conduct	-.437[a]	-4.227	.000	-.436	.986
2	Absences	-.009[b]	-.082	.935	-.009	.998
	Conduct	-.478[b]	-4.721	.000	-.479	.961

a. Predictors in the Model: (Constant), Band or Not
b. Predictors in the Model: (Constant), Band or Not, Propensity Score
c. Dependent Variable: Reading Standard

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	79.414	118.848	108.549	6.0345	79
Residual	-27.5324	17.5284	.1684	10.0822	79
Std. Predicted Value	-4.834	1.708	-.001	1.001	79
Std. Residual	-2.653	1.689	.016	.972	79

a. Dependent Variable: Reading Standard

Appendix B: Part 2 Regression Results – Math

Descriptive Statistics

	Mean	Std. Deviation	N
math Standard	108.777	11.2568	80
Band or Not	.41	.495	80
Propensity Score	.41250	.100461	80
Absences	5.66	4.579	79
Conduct	2.30	3.953	79

Correlations

		math Standard	Band or Not	Propensity Score
Pearson Correlation	math Standard	1.000	.173	.205
	Band or Not	.173	1.000	.204
	Propensity Score	.205	.204	1.000
	Absences	-.118	.030	-.024
	Conduct	-.509	-.118	-.179
Sig. (1-tailed)	math Standard	.	.062	.034
	Band or Not	.062	.	.035
	Propensity Score	.034	.035	.
	Absences	.150	.397	.416
	Conduct	.000	.151	.057
N	math Standard	80	80	80
	Band or Not	80	80	80
	Propensity Score	80	80	80
	Absences	79	79	79
	Conduct	79	79	79

Correlations

		Absences	Conduct
Pearson Correlation	math Standard	-.118	-.509
	Band or Not	.030	-.118
	Propensity Score	-.024	-.179
	Absences	1.000	.109
	Conduct	.109	1.000
Sig. (1-tailed)	math Standard	.150	.000
	Band or Not	.397	.151
	Propensity Score	.416	.057
	Absences	.	.169
	Conduct	.169	.
N	math Standard	79	79
	Band or Not	79	79
	Propensity Score	79	79
	Absences	79	79
	Conduct	79	79

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Band or Not[a]	.	Enter
2	Propensity Score	.	Enter
3	Absences, Conduct	.	Enter

a. All requested variables entered.
b. Dependent Variable: math Standard

Model Summary [d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.173[a]	.030	.017	11.1586
2	.245[b]	.060	.035	11.0572
3	.535[c]	.286	.248	9.7648

Model Summary[d]

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	.030	2.379	1	77	.127
2	.030	2.419	1	76	.124
3	.226	11.725	2	74	.000

a. Predictors: (Constant), Band or Not
b. Predictors: (Constant), Band or Not, Propensity Score
c. Predictors: (Constant), Band or Not, Propensity Score, Absences, Conduct
d. Dependent Variable: math Standard

ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	296.193	1	296.193	2.379	.127[a]
	Residual	9587.651	77	124.515		
	Total	9883.844	78			
2	Regression	591.903	2	295.951	2.421	.096[b]
	Residual	9291.941	76	122.262		
	Total	9883.844	78			
3	Regression	2827.866	4	706.966	7.414	.000[c]
	Residual	7055.978	74	95.351		
	Total	9883.844	78			

a. Predictors: (Constant), Band or Not
b. Predictors: (Constant), Band or Not, Propensity Score
c. Predictors: (Constant), Band or Not, Propensity Score, Absences, Conduct
d. Dependent Variable: math Standard

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	107.154	1.638		65.419	.000
	Band or Not	3.934	2.550	.173	1.542	.127
2	(Constant)	99.325	5.289		18.779	.000
	Band or Not	3.115	2.582	.137	1.207	.231
	Propensity Score	19.798	12.730	.177	1.555	.124
3	(Constant)	107.340	5.076		21.145	.000
	Band or Not	2.258	2.290	.099	.986	.327
	Propensity Score	11.003	11.388	.098	.966	.337
	Absences	-.165	.243	-.067	-.677	.500
	Conduct	-1.347	.287	-.473	-4.691	.000

a. Dependent Variable: math Standard

Excluded Variables[c]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	Propensity Score	.177[a]	1.555	.124	.176	.958
	Absences	-.123[a]	-1.100	.275	-.125	.999
	Conduct	-.496[a]	-5.034	.000	-.500	.986
2	Absences	-.118[b]	-1.061	.292	-.122	.998
	Conduct	-.480[b]	-4.812	.000	-.486	.961

a. Predictors in the Model: (Constant), Band or Not
b. Predictors in the Model: (Constant), Band or Not, Propensity Score
c. Dependent Variable: math Standard

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	77.773	116.324	108.794	6.0235	79
Residual	-17.9096	19.1764	.0178	9.5715	79
Std. Predicted Value	-5.149	1.253	.003	1.000	79
Std. Residual	-1.834	1.964	.002	.980	79

a. Dependent Variable: math Standard