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Instrumental Music and Reading Achievement of First Graders

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This is to certify that the doctoral dissertation by

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Prior research studies point to a correlational relationship between music instruction and academic achievement studies, but varying results and confounding factors prevent causality. The purpose of this quasi-experimental study is to test Vygotsky's sociocultural cognitive theory that playing a musical instrument is significantly associated with academic achievement in reading for 1st graders who attend 1 of 2 schools in Alaska. Using Analysis of Covariance, this study investigates the relationship between instrumental music and academic achievement on measures of academic progress (MAP) reading scores of 1st graders (*n* = 76) who received at least 90 minutes per week of string instruction for 2 consecutive years at a Title I school in comparison with those who attended another Title I school without the string program. Although the results of this study did not show a relationship between instrumental music and academic achievement on MAP reading scores of 1st graders, this study has implications for positive social change. This study contributes to this new field of music for social change and underscores the need from public school administrators and music educators for more research at the local and national level on the benefits of music education as a contributor to academic achievement and student success.

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Dedication

This paper is dedicated to my parents. To my mom who raised three kids on her own after my father passed away. She taught me independence and self-reliance. To my father who received his doctorate in engineering *summa cum laude*. He inspired me to do the same.

Acknowledgments

I would like to thank my committee chair, Dr. Kay Abernathy, and methodologist, Dr. Wade Smith, for their guidance through this process.

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Chapter 1: Introduction to the Study

In the past decade, research studies (e.g., Holochwost et al., 2017; Moreno et al., 2009) point to a relationship between music instruction and academic achievement, but results vary between studies and extraneous variables prevent researchers from making causal connections linked to IQ, academic achievement, and specific cognitive domains. Of the literature reviewed, confounding variables such as socioeconomic status, failure to establish a random sample, and prohibitive access to instrumental music lessons challenge researchers seeking to confirm causation between music and achievement. In the area of reading and young children, several studies (Bhide, Power & Goswami, 2013; Chobert, François, Velay, & Besson, 2014; Kaviani, Mirbaha, Pournaseh & Sagan, 2014) show a correlation between music and improved skills related to reading (phonemic awareness, language processing, and verbal reasoning), but not directly to achievement on standardized test scores.

This research study addressed these gaps in the literature by exploring whether a program in which all first graders received 2 years of violin instruction as part of their school day at a Title I school in Alaska increased their standardized reading scores compared to students at another Title I school who had not received this training. The results of this study address potential implications for social change by providing free instrumental music as an early childhood reading intervention, which could contribute to academic achievement for students from lower socioeconomic backgrounds who may not otherwise afford it. If a positive significant effect was found, instrumental music might become a core part of every child's public school education and made accessible to all students, regardless of their financial means.

The major sections of this chapter outline the key aspects of this study: Problem statement, purpose of the study, research question and hypotheses, theoretical foundation, and nature of the study. Following these sections, I address key definitions, assumptions, scope and delimitations, and limitations of the study. The significance of the study and summary conclude this chapter.

Problem Statement

This quantitative study explored if a program in which all first graders received 2 years of violin instruction as part of their school day at a Title I school in Alaska increased their reading achievement. This study is relevant, current, and significant because it addresses a gap in research conducted in the last 5 years concerning music and reading skills of young children. Recent studies (e.g., Bhide et al., 2013; Chobert et al., 2014; Kaviani et al., 2014) show a correlation between music and improved language skills, but do not directly address achievement on standardized test scores. When public schools cut their music programs to balance shrinking budgets or fund additional instruction in tested core subjects like reading, students from lower socioeconomic backgrounds lose access to instrumental music and its potential impact on learning because of the prohibitive cost of the only remaining option, private lessons. This study addresses the problem of inequitable access for marginalized populations by providing instrumental music as an early childhood reading intervention, which could contribute to academic achievement for students from lower socioeconomic backgrounds who may not otherwise afford it, especially when the music training is required and free of charge.

Purpose of the Study

The purpose of this quasi-experimental study was to test Vygotsky's sociocultural cognitive theory that playing a musical instrument is significantly associated with academic achievement in reading for first graders who attended one of two schools in Alaska. According to Campbell and Stanley (2015), the quasi-experimental design involving both an experimental and control group is "one of the most widespread experimental designs in educational research" (p. 47) and often involves a convenient sample naturally grouped by classroom, grade, and school. The independent variable was violin instruction administered 90 minutes/week for 70 weeks over a 2-year period. The dependent variable was measures of academic progress (MAP) reading scores of first graders, and the control variables were ethnicity, gender, age, mobility, and socioeconomic status as defined by income eligibility guidelines for the Free and Reduced Lunch (FRL) program. These students were reasonable to compare because the students at these two schools received the same standardized test each year within similar time frames, were similar in demographics, used the same math and reading programs, and had comparable percentages of English language learners (ELLs) and students whose families are eligible for the FRL program.

Research Question and Hypothesis

The research question is: What is the relationship between instrumental music and academic achievement on MAP reading scores of first graders who received at least 90 minutes per week of string instruction for 2 consecutive years at a Title I school? The null hypothesis is there is no significance between the MAP reading scores of students receiving 2 consecutive years of string instruction and students receiving no string instruction. The alternative hypothesis is there is a significance between the MAP reading scores of students receiving string instruction and students not receiving string instruction. SPSS software was used to conduct analysis of covariance (ANCOVA) to measure the dependent variable of spring 2015 MAP reading scores of first graders and the covariate was fall 2013 MAP reading scores of kindergartners controlling for ethnicity, gender, mobility, and at-risk factors including socioeconomic status as defined by income eligibility guidelines for FRL. Students were identified as Alaska Native (AK), English Language Learner (ELL), and/or receiving special education services through an Individualized Education Program (IEP).

Conceptual Framework

According to Frankfort-Nachmias and Nachmias (2008), "Much of what is considered theory in the social sciences consists of conceptual frameworks, which can be used to direct systematic empirical research" (p. 35). As part of a conceptual framework, descriptive categories are grouped in such a way to provide explanations and predictors. Grounded in Vygotsky's sociocultural cognitive learning theory, which foreshadowed post-positivism, this study used cognitive tasks and pre- and post-tests to recognize knowledge as sensorial experiences that are verified through empirical evidence. Post-positivism is used in quantitative studies because it emphasizes reductionism, verification, empirical evidence, and the use of the scientific method (Creswell, 2009).

Post-positivists also recognize that all observations have error, which is why researchers collect multiple measurements to determine a more accurate reality.

Vygotsky's sociocultural cognitive theory best aligned with my study because of its emphasis on the interactions between social, environmental, and cognitive factors. Vygotsky (1962) asserted that children's development is inextricably linked to their cultural and social interactions. Through the use of tools specific to their environment, children learn to adapt and be successful in their culture (Santrock, 2009). Vygotsky's theory also focuses on "the bidirectional exchanges between the individual and peers, family, school, and community in which both parties contribute to the relationship" (Lerner et al., 2005, p. 23). Nature (cognition) and nurture (influence of others) both play an important role in development where Vygotsky viewed emotion and thinking as inseparable.

Key Vygotskian principles include situated learning, zone of proximal development (ZPD), socially shared cognition, joint activity, culture, context, and cognition. The ZPD relies upon teacher and peer-directed learning, scaffolded instruction, specific feedback, and gradual release of teaching responsibility. According to van Huizen, Oers, and Wubbels (2005), Vygotsky's theoretical framework is one that recognizes the interconnectedness of individual development and the sociocultural context in which that individual lives and interacts. Rather than society and individual at odds, the two work together. Individuals shape and are being shaped by their activity within a particular environment. The interplay of emotion and intellect assign meaning, and the interplay of personal and public meaning, in turn, define personal identity.

A conceptual framework grounded in Vygotsky's sociocultural cognitive theory best fit my research problem because it uses empirical evidence to help determine the interactions between cognition, culture, and the social context of the classroom. A more detailed explanation connecting Vygotsky's sociocultural cognitive theory to the approach of my study and research questions is provided in Chapter 2. My research problem examined whether playing an instrument increased academic achievement in reading, controlling for socio-economic factors, gender, ethnicity, and mobility for first graders at two elementary schools in Alaska.

Nature of the Study

I chose a quasi-experimental design for my research study because the target population was already grouped by classroom and school rather than by random assignment. I conducted an ANCOVA, which is a multiple regression model that includes three or more conditions and controls the effect that a covariate can have on the experimental outcome. The sample design I implemented was a nonprobability sampling because "there is no way of specifying the probability of each unit's inclusion in the sample" (Frankfort-Nachmias & Nachmias, 2008, p. 167).

When I conducted the ANCOVA, the independent variable was violin instruction administered 90 minutes/week for 70 weeks over a 2-year period. The dependent variable was MAP reading scores of first graders, and the covariate was MAP reading scores of those same students as kindergartners. Controlling variables were ethnicity, gender, mobility, and at-risk factors including socioeconomic status as defined by income eligibility guidelines for FRL and students identified as AK, ELL, and/or IEP. According to Field (2013), there are two reasons for including covariates: Reducing within-group error variance and eliminating confounding factors that can compromise the true effect of the experimental condition. The pretest given in kindergarten served as the covariate because as a baseline measure, I could determine whether the posttest means, adjusted for pretest scores, differed between the control and violin group. The two data points were a pretest given in kindergarten and a posttest administered 2 years later in first grade for both control and intervention groups who attended two different schools with comparable demographics. The unit of analysis was 76 first grade students attending two elementary schools in Alaska.

Because ANCOVA is a linear model, the same assumptions that must be met for ANOVA tests apply for ANCOVA, including normality, linearity, homogeneity of variance, and data cleaning to address outliers (Laureate Education, Inc., 2009). In addition to these assumptions, Field (2013) included two assumptions specific to ANCOVA: Homogeneity of regression slopes and independence of the covariate and experimental condition. According to Field (2013), "*homogeneity of regression slopes* assumption means that the relationship between the outcome (dependent variable) and the covariate is the same in each of our treatment groups" (p. 486). Other assumptions that needed to be met were normality of variables (no skewness or kurtosis) and the trimming of extreme outliers that could reduce the generalizability of the results (Laureate Education, Inc., 2009).

The advantage of this design is its ease with which to collect standardized test scores and its potential for generalizability through the use of secondary data. The limitation of a quasi-experimental design is its lack of a random sample, which impacts intrinsic factors of validity including the varied history and maturation of participants, as well as the unexpected drop out of participants from the study. I minimized these threats by using a frequency distribution to ensure that both intervention and control groups had similar percentages of relevant characteristics, a pre- and posttest, and a standardized MAP test that was evaluated for validity and reliability by Northwest Education Association (NWEA), an outside source.

Definitions

El Sistema: El Sistema is a music education program originating from Venezuela that emphasizes “intensive ensemble participation from the earliest stages, group learning, peer teaching and a commitment to keeping the joy and fun of musical learning and music making ever-present” (El Sistema USA, 2017a, para. 3). Music preparation is geared toward performing in orchestra ensembles; however, El Sistema also values and offers choral singing, folk music, jazz, and special needs programs.

Kindermusik: Kindermusik is a music education program for children from birth to seven years-old who develop social and academic skills through singing, moving, instrumental music and storytelling (Kindermusik, 2017).

Kodaly pedagogy: Kodaly is an approach to music education that incorporates singing traditional folk songs and games, sight singing through the use of solfege (a system of identifying pitches of a musical scale), and providing only quality music representative of the culture and/or composed by great classical composers (Organization of American Kodaly Educators, 2017).

Measures of Academic Progress (MAP): MAP assessments are computer adaptive tests in mathematics, reading, language usage, and science created by the Northwest Education Association (NWEA), which students take 3 times per school year to track student academic growth over time. (NWEA, 2017).

Orff-Schulwerk pedagogy: The Orff-Schulwerk approach to music education recognizes what children do instinctively: Play, imitate, experiment, and create through personal expression. Singing, dancing, chanting, and using percussion instruments to encourage improvisation are all a part of this ensemble-based pedagogy (American Orff-Schulwerk Association, 2017).

Socioeconomic status (SES): Socioeconomic status is the class of an individual based upon education, income, and occupation (American Psychological Association, 2017).

Suzuki pedagogy: Suzuki is a method of teaching the violin, typically to very young children in large groups, developed by Shin'ichi Suzuki, Japanese educationalist and violin teacher. Key principles of Suzuki pedagogy include parent involvement, early beginning, listening, repetition, encouragement, learning with other children, graded repertoire, and delayed reading (Suzuki Association of the Americas, 2017).

Title I: Title I refers to federal funding for schools with high percentages of children from low-income families to help these students meet state academic standards (U.S. Department of Education, 2017).

Assumptions

Several assumptions were made in this study. The treatment group received approximately 90 minutes per week of Suzuki violin as part of their kindergarten and first grade school curriculum while the control group received 45 minutes per week of general music. Both schools used the same math and reading programs and administered MAP assessments 3 times a year during the fall, winter, and spring trimester of each school year.

Scope and Delimitations

Researchers face the challenge of attaining both control (internal validity) and representation (external validity) when designing their studies. Ideally, a research study would reflect a representative population in a real-world setting while establishing causation by isolating an independent and dependent variable. According to Frankfort-Nachmias and Nachmias (2008), no design can adequately accomplish both types of validity and, therefore, researchers tend to consider internal validity more crucial than external validity. The experimental design establishes internal validity through three key components: Comparing, manipulating, and controlling variables.

Only the quasi-experimental and cross-sectional designs more adequately address the fourth component of research design, which is generalizability or the extent to which "the research findings can be generalized to larger populations and applied to different settings" (Frankfort-Nachmias & Nachmias, 2008, p. 520). I chose a quasi-experimental design for my research study because I explored whether an intervention (violin instruction) had a significant effect on a target population without random assignment. This was a longitudinal study because I gathered data for the same subjects over the course of 2 years. The participants formed a convenient sample naturally grouped by classroom, grade, and school.

The convenience sample was limited to four first grade classrooms at two Title I elementary schools in Alaska featuring comparable demographics. The standardized tests were limited to MAP assessments in reading and administered through the use of laptop computers. Title I schools often have a transient population, which resulted in participants leaving the school before the study was complete or new first graders entering the schools with or without previous violin training.

Limitations

This study contributed to a growing body of research related to music and academic achievement, but should not be generalized to a broader unit of analysis (ecological fallacy) or reduced to an individual (individualistic fallacy). To avoid committing these fallacies, it was my job as a researcher to state my results clearly. Using secondary data MAP scores also removed the researcher from the initial data collection process. As a music teacher, creator of the violin program, and researcher of this study, using secondary data ensured that my biases did not compromise the validity of the data collection or analysis.

Significance of the Study

The innovative element of this study is the use of instrumental music as an early childhood reading intervention for all students, especially those from lower socioeconomic background who may not otherwise afford music lessons. The results of this study support the basis for a paradigm shift away from schools viewing music as an elective and toward one that includes music as an integral component of the core curriculum in the elementary portion of the K-12 system, regardless of family means.

Whether it is applicable to the middle and senior portions of the K-12 system is open to conjecture.

This research study carries social change implications by examining the academic impact that a music intervention has for students with low socioeconomic backgrounds who would not be able to afford music lessons otherwise. My social change proposal could help confirm a link between music instruction and reading skills, with a large participant pool of 38 first graders who have played violin for 2 school years over a 70-week period. The data collected from this longitudinal study also could contribute to the link between increased duration of instrumental instruction and academic achievement, which would provide support for the expansion of my social change proposal to all grades K-12.

Finally, since the school district administers standardized test scores for kindergarten, first grade, and second grade students, I used secondary data MAP assessments to compare the scores of students participating in my social change project against non-participating students. The El Sistema-inspired violin program that I have begun in Alaska is one of many similar programs cropping up all over the United States. The opportunity for similar studies to be conducted in different schools, geographic locations, and demographics is more likely to occur when these studies use common testing formats like MAP testing.

Summary

Of the literature reviewed, confounding variables such as SES, failure to establish a random sample, and prohibitive access to instrumental music lessons challenge researchers seeking to confirm causation between music and reading achievement. This study addressed the problem of inequitable access to music instruction for marginalized populations by providing free instrumental music as an early childhood reading intervention, which could contribute to academic achievement for students from lower socioeconomic backgrounds who may not otherwise afford it.

To address gaps in the literature conducted in the last 5 years concerning music and reading skills of young children, this quantitative study tested Vygotsky's sociocultural cognitive theory that playing a musical instrument is significantly associated with academic achievement in reading for first graders who attended one of two schools in Alaska. A conceptual framework grounded in Vygotsky's sociocultural cognitive theory best fit my research problem because it uses empirical evidence to help determine the interactions between cognition, culture, and the social context of the classroom. A more detailed explanation of the methodology used for this study is provided in Chapter 3. Chapter 2 provides a summary and analysis of literature published in the past 5 years pertaining to the main themes of this research study.

Chapter 2: Literature Review

In the past decade, research studies point to a relationship between instrumental music instruction and academic achievement (e.g., Holochwost et al., 2017; Moreno et al., 2009). Of the literature reviewed, confounding variables such as SES, failure to establish a random sample, and prohibitive access to instrumental music lessons challenge researchers seeking to confirm causation between music and achievement. The purpose of this quasi-experimental study was to test Vygotsky's sociocultural cognitive theory that playing a musical instrument is significantly associated with academic achievement in reading for first graders who attended one of two schools in Alaska.

I narrowed my search to quantitative studies published within the past five years and involving participants aged 5-8, instrumental music programs including school-based and El Sistema-inspired programs, and music to language transfer. I explored these topics in the context of reading skill development and/or reading achievement. Of the literature reviewed, 41 studies involved (but were not exclusive to) participants ages 5 -8. Thirty-three of the 41 studies were longitudinal, of which 19 involved instrumental music training versus rhythmic tapping or computerized/general music classes. The longitudinal studies which involved instrumental music training ranged from 1 to 6 years in length of which, six included randomly assigned control and intervention groups. The remaining studies indicated quasi-experimental groupings involving students already enrolled in music programming or classroom settings. All nine El Sistema-inspired studies except one were conducted at one of two Los Angeles-based community programs. Sample sizes for the 41 studies ranged from 19 to 747 participants (M=123).

Literature Search Strategy

The key subject areas of music, reading skills, and cognition formed the basis of this literature review and the following themes: Phonological awareness, rhythm skills, speech-in-noise, El Sistema programs involving low socioeconomic populations, commencement age and duration of instrumental training, executive function, and special populations. The Walden Library databases were used to locate peer-reviewed articles primarily published between 2012 and 2017 except for seminal articles related to instrumental music and cognition. Databases included Academic Search Complete, EBSCOHost, Education Source, Elsevier, SAGE Premier 2017, ScienceDirect, Taylor and Francis Online, and Wiley Online.

Google Scholar also was used to identify scholarly journals, including those found on the National Center for Biotechnology Information (NCBI) database. Reference lists also provided a reliable source of peer-reviewed articles. The following key search terms and combination of search terms were used to locate nearly 80 articles published between 2012 and 2017: *Academic achievement*, *brain plasticity*, *children*, *cognition*, *dyslexia*, *early childhood*, *El Sistema*, *executive function*, *in-school music*, *instrumental music*, *language transfer*, *longitudinal, music*, *music duration*, *music training*, *phonological awareness*, *preschool, reading*, *reading comprehension*, *rhythm*, *school-based music*, *sensitive periods*, *speech*, and *speech-in-noise.*

Conceptual Framework

Vygotsky's sociocultural cognitive theory provided the conceptual framework for my research study because of its emphasis on the interactions between social, environmental, and cognitive factors. Vygotsky (1962) asserted that children's development is inextricably linked to a child's cultural and social interactions. Through the use of tools specific to their environment, children learn to adapt and be successful in their culture (Santrock, 2009). My research question focused on the impact of group violin lessons on reading achievement for first graders.

Key principles of Vygotsky's sociocultural cognitive theory include situated learning, zone of proximal development (ZPD), socially shared cognition, culture, context, and cognition. ZPD relies upon teacher and peer-directed learning, scaffolded instruction, specific feedback, and gradual release of teaching responsibility. Learning how to play an instrument in a school ensemble involves all of these practices. Several studies in this literature review recruited participants from El Sistema-inspired programs, which serve children of low SES and focus on peer-mentoring and leadership skills.

El Sistema is a social service program that uses the power of music and social experience of playing in an ensemble as a model for an ideal society where each member strives together to contribute something of value to the greater good. Vygotsky viewed the acquisition of language as a socially shared activity in which the individual internalizes the effects of working together. The articles included in this literature review examined the impact of instrumental music on cognition, particularly in the areas of language development. Vygotsky also emphasized the importance of emotion in the learning process and viewed emotion and thinking as inseparable. Music engages both.

A conceptual framework grounded in Vygotsky's sociocultural cognitive theory best fit my research problem because it uses empirical evidence to help determine the interactions between cognition, culture, and the social context of the classroom. My research problem examined whether playing an instrument increased academic achievement in reading, controlling for socioeconomic factors, gender, ethnicity, and mobility for first graders at two elementary schools in Alaska.

Phonological Awareness

Music training supports the development of phonological awareness (e.g., Degé & Schwarzer, 2011), which is one of the precursors of reading. The majority of past studies have focused on the relationship between music perception abilities and phonological awareness, but Degé, Kubicek, and Schwarzer (2015) examined both music perception and music production as they relate to phonological awareness and other precursors of reading, including working memory and rapid retrieval from long-term memory. Fifty-five preschoolers aged 6 from five different kindergartens in Giessen, Germany were recruited and assessed in groups on measures of intelligence and music perception, as well as individually on precursors of reading and music production tasks. The music production subtests included singing a song and executing rhythm and meter. All confounding variables (age, gender, and socioeconomic status) were not significantly correlated with musical abilities except for IQ, which was significantly correlated with music production and perception and thus controlled in further statistical analyses.

Degé et al. (2015) found that musical abilities were more closely associated with phonological awareness at the word level (rhymes and word segmentation) than the phoneme level (phoneme recognition) and that working memory was correlated with both rhythm perception and production. The only significant relationship occurred between meter production and phonological awareness, whereas rhythm production and perception were marginally significant to working memory. Because Degé at al. (2015) calculated 64 correlations, they acknowledged the concern of alpha inflation. When adjusted, the only reliable correlation remaining occurred between music production and phonological awareness. Although this correlational study cannot make any causal links, Degé et al. (2015) said that training should include not only music listening skills, but also music production skills.

Moritz, Yampolsky, Papdelis, Thomson, and Wolf (2013) conducted a correlational study involving 30 kindergartners aged 5 that examined the link between a kindergartner's rhythm skills and phonological awareness. Also Moritz et al. (2013) included an intensive music intervention for the experimental group and a longitudinal study reexamining the impact of music training on phonological awareness skills of participants after completing Grade 2. The study involved two groups: An experimental group who received five weekly 45-minute Kodaly-based music lessons and a control group who received one 35-minute general music class per week. The Kodaly-based classes included folk songs, singing games, rhymes, and the performance of rhythm patterns and steady beat.

Moritz et al. (2013) found that a kindergartner's rhythm ability significantly correlated with phonological awareness skills in Grade 2. No significant differences existed between the two groups regarding demographics, income, home literacy, or music environment factors. Parents of the music group had significantly higher average levels of education, which may be attributed to the different schools from which the two groups were recruited. The music group attended a charter school, while the control group attended one of two public kindergarten classes in the Boston-area. The quasi-experimental design and small sample size (only 12 Grade 2 students participated in the longitudinal study) also limited the validity of the results supporting rhythm sensitivity as a pre-cursor skill of phonological awareness.

Patscheke Degé and Schwarzer (2016) addressed the limitations found in Moritz et al. (2013) by conducting a longitudinal study that randomly assigned 39 preschoolers aged 4-7 of immigrant families to one of three groups: Music, phonological skills training, or sports. All three groups received training 3 times a week for 20 minutes each for 14 weeks. The music group participated in singing, drumming, dancing, and rhythmic exercises, while the phonological skills training group had listening and rhyming tasks, phoneme recognition and syllable exercises, and an introduction to the concepts of "words" and "sentences." The sports group focused on motor skills and coordination through yoga-based activities.

Significant differences found in pretests between experimental and control groups in IQ (Degé et al., 2015) and parent education levels (Moritz et al., 2013) was not a limitation in the Patscheke et al. (2016) study. After pretests, Patscheke et al. (2016) found no significant differences between the three groups in intelligence, age, gender, SES, language background, and music experience of both child and parent. After the 14-week training, Patscheke et al. (2016) conducted a posttest and found that both music and phonological skills groups showed a significant increase in phonological awareness on the word level (blending, segmentation, and rhyming), supporting the results of Degé et al. (2015). Worth noting is the effect size of the music group (*dcorr* = 0.82), which was larger than the phonological group (*dcorr* = 0.35). The sports control group showed no significant increase in phonological awareness. Patscheke et al. (2016) addressed some of the limitations noted in the previously mentioned studies (Degé et al., 2015; Moritz et al., 2013) by conducting a randomized, longitudinal study and including a control group (sports) which received the same amount of training as the experimental groups to eliminate any effects of extra attention. One limitation effecting all three studies (Degé et al., 2015; Moritz et al., 2013; Patscheke et al., 2016) was the small sample size.

Kempert et al. (2016) addressed the challenge of a small sample size by conducting a longitudinal study involving 424 German-speaking children aged 4-5 recruited from 34 preschools. The quasi-experimental study examined whether music training combined with a well-established phonological awareness training would have a stronger impact on phonological awareness skills than the phonological awareness training alone. The participants were placed in three groups: Music and phonological skill training, phonological skill training only, and no special training. Music training was delivered between January and May of the first year of preschool, and then both experimental groups received phonological training between January and May of their second year of preschool. The control group received neither of these interventions.

The music intervention that Kempert et al. (2016) delivered followed a German early music education curriculum, which included exercises in meter, rhythm, pitch, notation, melody, dancing, singing, drumming, and listening to and playing music. The 2-year study included a pretest-posttest design with four measurement points. Kempert et al. (2016) confirmed a positive relationship between musical abilities and phonological awareness. However, their results contradicted those of Patscheke et al. (2016) by finding that the addition of either training (music and phonological awareness) did not significantly contribute to phonological awareness (broad or narrow) for children with normally- or weak-developed skills. Also, since the music intervention focused on both music perception and production, the results differed from Degé et al. (2015) which found music production a key component of developing phonological awareness skills.

Although Kempert et al. (2016) addressed a gap in previous studies by including a large sample size, the design had several limitations. One inconsistency was the length of interventions: The phonological skills training occurred daily over 20 weeks, while the music training only occurred 3 times per week over 16 weeks and then discontinued for the second year of preschool. Also, the test instruments were changed between year one and two of the study to avoid ceiling effects, making it impossible to analyze the development of all three groups across the four measurement points. The music training also occurred when the participants were on average 1 year younger than those studies investigating the impact of music on early phonological awareness interventions (Degé et al.2015; Moritz et al., 2013; Patscheke et al., 2016). According to Kempert et al. (2016), “Theoretical considerations as well as results of other studies (Gathercole and Baddeley, 1993; Rothe et al., 2004) suggest that there might be a certain minimum age for the successful promotion of phonological awareness. This might also apply to the promotion of phonological skills by a musical training" (p. 13). Kempert et al. (2016) also acknowledged that their study lacked a treated control group to control for the effects of an additional enrichment (i.e., motivation, social interaction, and adult support).

Each study (Degé et al., 2015; Kempert et al., 2016; Moritz et al., 2013: Patscheke et al., 2016) differed in the intensity of the music intervention delivered, impact of music perception versus production on phonological awareness, and limitations in research design including small sample size, nonrandomized groupings, and lack of treated control group, but all supported a positive relationship between music skills and phonological awareness for children aged 4-7. Rhythm is another area of focus for researchers interested in examining the impact of music on reading skills.

Rhythm

Rhythm and the ability to tap or synchronize to a beat may help readers be more sensitive to speech segmentation, which is critical for the development of phonological awareness (Tierney and Kraus, 2013). Several studies examined rhythm and beat synchronization as a predictor for neural speech encoding and reading readiness in preschoolers (Carr et al., 2014), a determinant of individual differences in grammar skills (Gordon et al., 2015), musical intervention for poor readers (Bhide et al., 2013), and decoding skills of primary school children (Rautenberg, 2015).

Carr et al. (2014) recruited 35 children aged 3-4 from the Chicago area to determine whether individuals with poor beat synchronization skills also struggle with reading. Children were asked to synchronize their drumming with those of the experimenter who used drumming rates approximating phonemic rates. Twenty-two children were able to match the pattern of the experimenter's beat. This group formed Synchronizers (*n* = 22, 15 females), while the 13 who could not synchronize to the drumming formed Non-Synchronizers (*n* = 13, 3 females). The groups did not differ in age, verbal or nonverbal intelligence, or receptive vocabulary, but found that a higher ratio of males failed to synchronize (covarying for sex did not alter the results, so the covariate was not included). Using phonological awareness tests, the Synchronizers demonstrated better perceptual and cognitive language skills than the Non-synchronizers.

Carr et al. (2014) provided biological evidence that preschoolers unable to synchronize with a phonemic-paced drumbeat have poorer pre-reading skills in the areas of phonological processing, auditory short-term memory, and rapid naming. In addition, the study established a relationship between pre-reading skills, motor synchronization, and temporal precision. According to Carr et al. (2014), "Because beat synchronization abilities emerge at an early age, these findings may inform strategies for early detection of and intervention for language-based learning disabilities" (p. 14559). Gordon et al. (2015) also found that rhythm discrimination ability supported reading skills, but in the area of grammar production for 25 children aged 5-7. After controlling for non-verbal IQ, SES, music expertise, or phonological awareness, Gordon et al. (2015) found that rhythm perception accounted for 48% of the variance in syntactic competence, but did not find a consistent correlation between rhythm measures and phonological awareness. Gordon et al. (2015) made no mention of how participants were recruited, which compromised the validity of the study. Both Carr et al. (2014) and Gordon et al. (2015) measured a child's beat synchronization ability without providing a rhythmic intervention, whereas Bhide et al. (2013) and Rautenberg (2015) examined the impact an intervention focused on rhythmic entrainment had on the reading scores of participants aged 6-7.

Bhide et al. (2013) used a rhythm-based study to examine the effects of music training on reading scores of 19 children who were identified as struggling readers. The musical intervention was based upon the temporal sampling theory, which also served as the theoretical framework for the two previously mentioned studies (Carr et al., 2014; Gordon et al., 2015). According to Bhide et al. (2013), temporal sampling theory "proposes that underlying difficulty in neural rhythmic entrainment found across the IQ spectrum is one cause of the poor phonological skills in children who go on to become poor readers" (p. 113). The music intervention group (n=10) involved tapping a space bar in time with a metronome, identifying same and different metronome tempos, marching to music, and playing hand clapping games. The control group (n=9) participated in a child-friendly reading intervention program called GraphoGame. Both interventions took place over a 2-month period, for 19 sessions and 25 minutes each. Bhide et al. (2013) found that a rhythmic musical intervention had similar benefits for literacy as a software phoneme-grapheme intervention, but the small participant size and lack of control group (no treatment) prevented the authors from determining whether the gains in reading scores were due to the natural passing of time.

Rautenberg (2015) rectified the limitations of small sample size and lack of control group in Bhide et al. (2013) by conducting a quasi-experimental, longitudinal study, which included 159 slightly older children from eight different Grade 1 classes. These classes of German-speaking children were randomly placed into three groups: Two classes comprised a general music group based upon Gordon's Theory music pedagogy, two classes formed the visual arts group, and four classes comprised the control group, which received no special training. The music and visual arts classes met 2 times per week (duration not listed), over an 8-month period. The Gordon music training included rhythmic, tonal/melodic, and auditory discrimination skills, while the visual art classes focused on print-making using different materials and mediums.

With IQ and socioeconomic background controlled, Rautenberg (2015) conducted a pre- and posttest and found that rhythmical abilities had a highly significant effect on decoding skills at word level in both reading accuracy and prosody, but that tonal skills did not. Rhythmic ability included differentiation of rhythmic patterns and tone lengths (not tonal pitch). Rautenberg (2015) evaluated rhythm perception skills and found that rhythm abilities and beat synchronization were more relevant to reading skills than tonal ability. Synchrony also plays an important role in the language area of speech-in-noise. The process is called auditory neural synchrony or the auditory system's ability to accurately represent sound (Tierney and Kraus, 2013).

Speech Segmentation and Speech-In-Noise

Research studies involving children and music training (Kraus et al., 2014a, 2014b, 2015; Strait, Parbery-Clark, O'Connell, and Kraus, 2013b) also found that learning how to play an instrument improves a child's ability to perceive speech when it is presented in background noise. Strait et al. (2013b) found that commencement age and duration of playing an instrument had positive effects on how resilient neural encoding of speech-in-noise is for musicians with as little as 1 year of music training. Their study included 32 normal hearing children aged 3-5 who were placed in two groups: A music group (*n*=18) who received 12 consecutive months of music training (duration of music training *M*=2.4 years) in Kindermusik, Orff-Schulwerk, or Suzuki music classes or the nonmusician group (*n*=14) who had no previous music training. Results indicated that the music training group demonstrated shorter quiet-to-noise timing delays and onset peak degradation, as well as faster neural responses to speech in both quiet and noise conditions than those who received no music training. The additional year of continued music training also protected against the adverse effects of background noise. Although Strait et al. (2013b) found that musician preschoolers had faster neural timing and less timing delays for processing speech, they did not find the additional enhancements observed in older children through their 2012 study.

In contrast, Strait, Parbery-Clark, Hittner, and Kraus (2012) found additional enhancements in quiet and speech-in-noise environments involving 28 normal hearing children aged 7-13. Strait et al. (2012) included 15 children who were self-categorized as musicians, began private instruction before age 5, and had played consistently for 4 years. The nonmusician (*n*=13) group had no prior musical training experience. Although the study cannot claim causality, Strait et al. (2012) asserted that “the musician enhancement for the perception and neural encoding of speech in noise arises early in life, with more years of training relating with more robust speech processing in children (pp. 195-6). Strait et al. (2012) also offered an alternative hypothesis that children who started playing at an earlier age may be genetically predisposed to having a more developed neurosensory function. Without a randomized sample, Strait et al. (2012) could not answer whether auditory improvement is linked to pre-existing differences rather than training or experience.

The longitudinal study by Slater et al. (2015) addressed the question of nature versus nurture by randomly selecting 36 children aged 7 and followed them for 2 years to determine whether music training improves a child's ability to extract meaningful information from competing sounds or noise. The children were recruited from a waitlist of Harmony Project, an El Sistema-inspired community-based program in Los Angeles that provides free instrumental music training to underserved children. The children were assigned to two groups: Group 1 (n=19) enrolled in Harmony Project during the first and second year of the study, while Group 2 (n=27) acted as a control and waited a year before entering the music program. There were no significant differences between the groups at the initial assessment before training regarding age, sex, verbal and non-verbal IQ, maternal education (SES), speech-in-noise perception, and age of acquisition of English.

Results of Slater et al. (2015) showed improved hearing in noise with music training within the context of a tuition-free ensemble-based program involving underserved students. The randomized and longitudinal design of Slater et al. (2015) not only provides evidence that the improvement is linked to experience, but also includes an underserved population often excluded from research studies involving music because of the financial barrier of taking private lessons (Kempert et al., 2016; Mehr, Schachner, Katz, & Spelke, 2013; Moritz et al., 2013, Nutley et al., 2013; Putkinen, Tervaniemi, Saarikivi, Ojala, & Huotilainen, 2014). Several studies (Habibi et al., 2014; Holochwost et al., 2017; Krauss et al., 2014a, 2014b, 2014c, Kraus et al., 2015; Slater et al., 2013, 2014, 2015) were conducted at music sites inspired by a program called El Sistema, which provides musical training to underserved children and has contributed current research in the field of music training and language transfer.

El Sistema-Inspired Programs

El Sistema is a social service program originating from Venezuela where music is used as the vehicle for social change. Dr. Abreu, an economist, musician, and founder of El Sistema, viewed the orchestra as a metaphor for an ideal society where each member strives together to contribute something of value to the greater good (J. Abreu, personal communication, April 2009). El Sistema is a network of ensemble-based music centers or "nucleos" where 70% of over 350,000 students a year live below the poverty line and whose teachers seek to create confident, successful citizens in the country's youngest generation. In its 35-year history, El Sistema has reached over 4 million youth by placing instruments in young children's hands. El Sistema has inspired countries throughout the world to create similar programs focused on providing access and equity to underserved populations. My research project comprises of students who attend a Sistema-inspired program in Alaska and is based upon similar values and goals.

El Sistema and music to language transfer. By conducting randomized, longitudinal studies involving students from low SES backgrounds, several studies (Habibi et al., 2014; Holochwost et al., 2017; Krauss et al., 2014a, 2014b, 2014c, Kraus et al., 2015; Slater et al., 2013, 2014, 2015) conducted at Sistema-inspired programs helped advance the notion that the brain can change through a child's interaction with a musical environment. Slater et al. (2014) conducted another longitudinal study at Harmony Project, an El Sistema-inspired program in Los Angeles. The study examined whether 42 Spanish-English bilingual children aged 6-9 participating in a community-based music class for 1 year would outperform their untrained peers on standardized reading measures. Like Slater et al. (2015), students were recruited from a waitlist to attend Harmony Project. Children received group instrumental instruction after completing a 6-month introductory music appreciation class focused on recorder playing, rhythmic and melodic skills, and vocal performance. Forty-four children aged 6-9 were pseudo-randomly assigned to a music or control group after an initial assessment that matched groups according to age, sex, handedness, IQ, age of English acquisition, reading ability, and maternal education. Slater et al. (2014) determined that the reading scores of students in the music training group did not improve, but rather maintained their age-normed level, whereas the control group showed a decline in reading scores. Slater et al. (2014) interpreted the results as evidence that music participation may counteract the negative impact that participants from low SES and bilingual families may have on maintaining literacy levels.

In three longitudinal studies spanning 2 years, Kraus et al. (2014a, 2014b, 2014c) examined whether instrumental music spurs neuroplasticity and language development, neural encoding of speech, and biological changes in auditory processing in underserved youth aged 6-10. All three studies were conducted at Harmony Project in Los Angeles. Twenty-six children participated in the 2-year Kraus et al. (2014a) study exploring whether greater engagement (defined by attendance and classroom participation) in music instruction positively impacts neural encoding of speech or how neurons represent sound with electrical activity. Kraus et al. (2014a) involved four sites where programming varied between 2 to 4 hours per week. Students' instrumentation also varied and included string, brass, and woodwind instruments. A reading test fluency pretest was administered before students entered the program and a posttest after 2 years of participation in the program.

Kraus et al. (2014a) found that students who demonstrated more engagement in the instrumental music classes developed stronger neural encoding of speech and increased reading scores, while those less engaged showed no improvements, thus advancing that greater engagement in music class predicts stronger speech encoding, not vice versa. To counter the argument that another extracurricular activity might yield the same results, Kraus et al. (2014a) cited Moreno et al. (2009), which included a painting control group and still found stronger auditory skills in the music group. To distinguish the impact that active engagement with sound through instrumental music has on neural processing versus a more passive music appreciation class, Kraus et al. (2014c) followed a small participant group of students ($n = 19$) at Harmony Project for 1 year and found that neural processing in speech was stronger and faster for coding of consonants. Although this study provided a random sample, it was compromised by a small participant group and lack of control group.

To help rectify these limitations, Kraus et al. (2014b) conducted another study at Harmony Project that examined whether participation in an established after-school community program would alter auditory neurophysiology and improve the neural process of speech syllables. Forty-four children were randomly assigned to undergo 1 year of music instruction immediately or defer their music training a year later. Both groups were matched for age, maternal education, hearing thresholds, and gender. Interestingly, duration played an important role in the results: Only children who participated in 2 years of music lessons showed improvement in neural differentiation of syllables, not those who participated for only 1 year. While Kraus et al. (2014b) provided a random sample for this study, they failed to include an active control group, participant size was relatively small (N=26), and the effect was also small $F(2,80) = 3.709$, $p = 0.029$). Despite its limitations, the neural improvement in year 2, but not year 1, of the program supports my research study, which examines students who have participated in at least 2 years of in-school violin instruction.

To contribute more evidence that music instruction impacts the brain, Habibi et al. (2014) provided baseline data through a 1-year study to answer the question whether children participating in an after-school music, athletic, or no extra-curricular program have pre-existing differences before training. Fifteen children aged 6-7 were placed in one of three groups (music, sports, or no program). Each group equally represented underserved minority populations primarily Latino and Korean. The music intervention took place at an El-Sistema-inspired program called YOLA at HOLA in Los Angeles. Habibi et al. (2014) found no significant differences in cognitive, motor, musical, emotional, or social behaviors, as well as structural and functional brain measures and plan to use these base level results for a future 5-year longitudinal study focused on music training and its effects on a child's cognitive, neural, and social-emotional development.

El Sistema and literacy skills. Duration of instrumental music also played a role in a research study by Holochwost et al. (2017) who contributed to the El Sistema field by conducting a longitudinal, random study with a control group and large-scale participant group of 265 children (Grades 1–8). One hundred thirty-five students formed the music group who participated in an after-school Sistema program in a parochial school in the Northeast United States. The students were selected by a lottery and divided into three subgroups: 1 year, 2 years or 3 years of participation in the program. These students met every day for 2 hours/week for 39 weeks. The control group of 130 students received no training. Holochwost et al. (2017) found that students enrolled in the music program exhibited higher scores in language and math in MAP standardized tests and improved measures of executive function and short-term memory. The greatest difference occurred between the control group and students who had participated in the music program for 2 or 3 years. This study not only supports the use of MAP scores to measure achievement in reading, but also provides inferences of causality through the use of a random sample.

Slater et al. (2013) conducted a longitudinal, randomized study that examined whether a year of music training would have an impact on the development of beat-keeping skills for 60 at-risk children aged 6-9. The study took place at Harmony Project in Los Angeles in which children were randomly assigned to two groups: A music group that received 6 months of music appreciation classes, followed by instrumental classes for the remainder of the year, and a control group who would join the music program the following year. Slater et al. (2013) found that 1 year of music training resulted in greater accuracy in a basic finger-tapping task than those in the control group. These findings contribute to an ever-growing field of study showing a link between rhythm abilities and reading performance.

Despite limiting factors of using small sample sizes and the same site for all three studies, Kraus et al. (2014a, 2014b, 2014c) contributed to the field of music training and its impact on cognition by addressing a gap in the research: The inclusion of children from families of low SES. This participant pool is relevant to my research study because I will conduct the violin intervention at a Title I school in which 39% of the population are eligible for FRL. The baseline data provided by Habibi et al. (2014) also supports my study because it indicated no pre-existing differences in children before musical training in cognitive, motor, musical, emotional, or social behaviors, as well as structural and functional brain measures. Along with similar studies conducted at other El Sistema programs (Holochwost et al., 2017; Slater et al., 2013), these longitudinal studies also contribute to the impact that duration of musical training has on increased cognition and academic achievement. In the following section, duration and commencement of musical training are examined.

Commencement and Duration of Musical Training

A seminal study by Schlaug, Norton, Overy, Winner (2005) not only addressed the question of pre-existing cognitive factors in musicians, but also provided evidence that both commencement and duration of musical training impact cognition and brain plasticity. Through their study of young children, Schlaug et al. (2005) examined whether pre-existing differences exist in cognition and brain structure/function between 50 children aged 5-7 who began violin or piano lessons and a control group of 25 children who were receiving no instrumental training. In their baseline assessments, Schlaug et al. (2005) found no differences on any measures between the two groups including age, gender distribution, or verbal intelligence. However, after 15 months of music instruction, these young musicians outperformed the control group in verbal ability, fine-motor sequencing tasks, and melody and rhythmic discrimination. Certain areas of the brain physically changed too. The auditory regions and the corpus callosum, which connects the two hemispheres, were enlarged with the greatest difference occurring over time for those children who practiced more frequently. Schlaug et al. (2005) provided causal evidence of the positive role that music training has on brain plasticity and cognition for young children.

Strait, O'Connell, Parbery-Clark, and Kraus (2013a) also examined the impact of early musical training by examining a cross-section of 76 normal hearing children and adults aged 3-30. The participants were placed into three groups by age: 21 preschoolers aged 3-5, 26 school-aged children aged 7-13, and 25 adults aged 18-30. The groups were further divided by musicians or nonmusicians. The criteria for the musician group included weekly instruction and at least at-home practice 4 days per week. All of the musicians had begun music training by or before age 7. Preschool nonmusicians had no music training the year before the study began. While IQ did not differ between-groups, musician school-age children and adults outperformed nonmusicians on auditory working memory and attention, while the neural encoding of stop consonants was observed in musician children as early as age 3, indicating a positive music transfer to language skills. The cross-sectional design of Strait et al. (2013a) cannot eliminate possible innate characteristics of musician's cognitive function.

Skoe and Kraus (2013) also conducted a cross-sectional study with a wider range of participants (*N*=747) spanning ages 2-72 placed into eight age groups and further delineated in each group by musician (*n*=213) and nonmusician (*n*=534) subgroups. Skoe and Kraus (2013) examined the interaction between experience-related brain plasticity and developmental plasticity and found that the brain had heightened responses at distinct times throughout an individuals' lifespan, which coincided with developmental sensitive periods. In particular, Skoe and Kraus (2013) found that the participants who started music instruction before age 7 and continued to play for subsequent years showed more brainstem responses to sound than those who did not receive music training. Again, the nature of this design cannot make a causal link but does suggest that both commencement age and duration of playing an instrument contributes to brain plasticity.

Hudziak et al. (2014) involved 232 youths ranging from 4 to 18 years of age and examined the number of years a participant played an instrument. The study concluded that the more a child trained on an instrument, the greater increase in cortical maturation, which helps with attention in skill, managing anxiety, and controlling emotions. Hudziak et al. (2014) also found that time playing an instrument for youth under age 10 was positively linked with cortical thickness in brain regions, including the right dorsolateral prefrontal cortex, which is involved in working memory, planning, cognitive flexibility, and abstract reasoning. Hudziak et al. (2014) results suggest that exposure to early music training may contribute to long-term cortical thickness development, but cannot confirm a causal link because of the quasi-experimental design of the study.

Commencement and duration continued to have a significant impact on brain plasticity as evidenced by Vaquero et al. (2016) who studied 36 expert pianist graduates from Hannover University of Music, Drama, and Media and 17 nonmusicians. The 36 musicians were split into early (21 before age 7) and late (after age 7) starters. Even when performance level was controlled, Vaquero et al. (2016) found that the earlier the onset, the better the piano performance and the smaller the gray matter volume in the right putamen, which indicated neural efficiency. Vaquero et al. (2016) confirmed some of the previous reports (Hudziak et al., 2014; Skoe and Kraus, 2013; Schlaug et al., 2005) regarding plasticity effects induced by sustained and repetitive music practice. Moreover, Vaquero et al. (2016) observed that neural efficiency due to intensive and long-term skill training seems to be determined by the age of commencement of musical practice.

Steele, Bailey, Zatorre, and Penhune (2013) and Bailey, Zatorre, and Penhune (2014) separated the impact that commencement age of musical training has on brain plasticity versus duration of musical training by designating two experimental groups: One that initiated training before age 7 and one that began after age 7. Both studies matched these groups for year of musical training and years of formal training, but Bailey et al. (2014) included a control group of nonmusicians, whereas the Steele et al. (2013) study did not. Steele et al. (2013) placed 36 highly trained musicians into two groups to examine whether white-matter development in the brain's corpus callosum would differ between an early training group who began music lessons before age 7 (*n*=18) and a late training group who began musical training after age 7. According to Steele et al. (2013), white matter fibers connect sensory and motor regions, which contribute to better sensorimotor integration. All musicians played an instrument requiring the coordinated use of both hands. Total years of experience ranged between 9 and 25 years with a mean of 16 years.

Bailey et al. (2014) explored how sensitive periods in the brain may be influenced by the coupling of intensive experiences with maturational plasticity. The researchers involved three groups to examine the impact musical training has on gray matter structure within the auditory-motor network before the age of 7. Fifteen musicians began practice before age 7, while 15 musicians began training after age 7, and 30 were nonmusicians. Gray matter, which helps humans process information, have more cell bodies and less-myelinated axons than white matter. Both Steele et al. (2013) and Bailey et al. (2014) found a positive relationship between early-trained musicians and brain plasticity. Steele et al. (2013) found that training before age 7 contributed to greater connectivity in the area of the brain related to sensorimotor synchronization performance. Although both Bailey et al. (2014) and Steele et al. (2013) recognized that genetic and other experience-based factors might be at play, they both proposed that musical training before the age of 7 can positively alter the brain's structure and function upon which ongoing experiences can build (Steele et al., 2013).

Chobert et al. (2014) found duration a determinant in improving acoustic and phonological cues of young children receiving a minimum of 6 months of music. Chobert et al. (2014) and François, Chobert, Besson, and Schön (2013) conducted longitudinal studies using the same randomly assigned participant group of children in Grade 3 in Southern France. Twenty-four students from two elementary schools were randomly assigned to take either a music or painting class. From October to May, the classes took place twice a week for 45 minutes each during the first year and one session of the same length for the second year. The music classes involved Orff-Schulwerk and Kodaly methods, which are both general music pedagogies involving skill development in rhythm, melody, harmony, and timbre.

Both control and intervention groups of Chobert et al. (2014) and Francois et al. (2013) had similar SES (middle to low social class), as well as results on standardized tests measuring verbal comprehension, verbal and nonverbal reasoning abilities, working memory, and visual and auditory attention. After 1 year, these two studies found that children who received music training were more sensitive to acoustic and phonological cues (Chobert et al., 2014) and had improved speech segmentation abilities (Francois et al., 2013) than the painting control group. Francois et al. (2013) determined that music training's "impact on brain plasticity goes beyond the auditory system tapping onto the dorsal and ventral pathways in which seem to play an important role in language acquisition and higher order processes" (pp. 2041-2042).

François et al. (2013) found no significant improvement on intelligence tests after 1 year of musical training, which contradicted Kaviani et al. (2013) who conducted a study in Tehran involving 60 randomly assigned pre-school children aged 5 and 6. Matched for sex, age, and mother's educational level, one group received 12 weekly Orff-Schulwerk music lessons for 75-minutes each, while the control group received no music training. All participants were recruited from public kindergarten and community music schools and were administered four subsets of Tehran-Stanford-Banet Intelligence test before training. Controlling for confounding variables (gender, previous music training, and mother's educational level), Kaviani et al. (2013) found that students who received music lessons showed significant IQ increase in verbal reasoning and short-term memory subtests, but not numerical and visual/abstract reasoning abilities.

Hyde et al. (2009) studied the structural brain changes in young children aged 6 who received keyboard instruction for 15 months compared to those in a group who did not. All 31 children received pre- and post-MRI scans to identify differences in brain size between the control and intervention groups. They were all closely matched in gender, SES, and age. Prior to any musical training there were no behavioral or brain differences. After 15 months of keyboard instruction, Hyde et al. (2009) found that the musicians showed greater improvement on the musical-related tasks, but not the nonmusical ones. Structural changes in the brain were found in the motor and auditory areas of the test group, which were consistent with findings of Forgeard et al. (2008) who also showed a correlation between musical training and near transfer skills, including fine motor skills and auditory discrimination.

Moreno et al. (2009) and Hyde et al. study (2009) both used music as an intervention for young children who had no prior music training. Moreno et al. (2009) provided a group of 8-year old children with no music training 24 weeks of music instruction, while the control group received painting lessons for the same period of time. All of the participants were 8-years of age and recruited from two elementary schools in

Aveiro, Portugal. The intervention by Moreno et al. (2009) did not provide instrumental music training, but rather general music instruction including Kodaly and Orff-Schulwerk pedagogies. After the 24-week period, both groups took the same battery of general IQ, verbal memory, reading, and pitch discrimination tests as a posttest. Moreno et al. (2009) found that musical training enhanced pitch discrimination in speech and improved reading skills, particularly where the phoneme-to grapheme correspondence was complex (where the pronunciation cannot be derived by rules). Of particular note was the extra-attention required to discriminate pitch in musical activity but not exercised for simple speech recognition tasks.

Forgeard et al. (2008) conducted a quantitative study to determine if instrumental music training had far transfer into other cognitive domains, including spatial, verbal, nonverbal, and mathematical. The participants included 59 children with a median age of 9.96. All were recruited from community music and public schools in the Boston area. Forty-one of the children had three years of instrumental training: 22 children played the keyboard, 12 played a stringed instrument, and 10 played both piano and a stringed instrument. Within the instrumental group, 21 received traditional music instruction, which included reading notation, while the other 20 received Suzuki instruction. The remaining 18 children formed the control group with no instrumental training. Contrary to previous studies, Forgeard et al. (2008) did not find a correlation between musical training and spatial reasoning, mathematical skills, and phonemic awareness, but did find a strong relationship between musical training and verbal and nonverbal reasoning. In addition, a correlation was found between the duration of music instruction and vocabulary and non-verbal reasoning. Hyde et al. (2009) and Forgeard et al. (2008) respectively indicated that plasticity could occur in brain regions that control primary functions important for playing a musical instrument, and also in brain regions that might be responsible for the kind of multimodal sensorimotor integration likely to underlie instrumental learning.

Trainor, Shahin, and Roberts (2009) also confirmed the effect that music has on enhancing the brain's auditory cortex, but unlike Hyde et al. (2009) and Forgeard et al. (2008), could only suggest a possible link to the brain's motor region. Trainor et al. (2009) used gamma-band activity to test three groups of adults: 11 professional violinists, 9 amateur pianists, and 14 non-musicians who had no formal music training. The researchers also tested 12 children aged 4-5. Six of these students had just begun Suzuki piano lessons while the other half had no musical training. Trainor et al. (2009) concluded that induced gamma-band responses to musical sounds were larger in adult musicians than non-musicians and that the professional violinists showed the largest enhancement. According to Trainor et al. (2009), the difference in the responses may have been due to the nature of the violin, which is not a fixed-pitch instrument and may require more attentional resources to discriminate slight differences in pitch. Trainor et al. (2009) also confirmed that these gamma-induced responses develop in children after one year of musical training but not for the non-musician group. Interestingly, adults who physically engaged in the practice of music achieved a larger change in the auditory cortex than those who passively listened to music.

Wetter, Koerner, and Schwaninger (2009) also found that students aged 9-12 who played an instrument had significantly higher scores in both overall as well as subject-specific (except in sports) compared to those students who did not receive any music instruction. School subjects included German, French, math, history, geography, handicraft, music, and sports. Teachers from both schools in Switzerland anonymously selected the students and confirmed through parent and student discussions those students who practiced an instrument regularly. Even after grade level, gender, and parent income predictors were held constant, music still proved to be more highly significant. Wetter et al. (2009) also found that academic achievement increased with increased years of music playing and supported the findings of Forgeard et al. (2008) whose participant pool also included children aged 9-12. Although these findings do not establish a causal link between instrumental instruction and academic achievement, they do advance a strong correlation between increased years of instrumental music instruction and increased overall academic performance.

Meyer et al. (2011) conducted a research study similar to my research plan by employing a cohort study of Suzuki students who all began violin training at approximately 5 years of age, attended a Suzuki school for an average of 5 years, and practiced between 90 and 485 minutes a week. Meyer et al. (2011) found that the "earlier children start with Suzuki training and the more intensely they practice playing the violin, the more salient is the mismatch response to selective deviant acoustic cues" (p. 763). Implications of this study help fill a gap in the research by exploring the impact of instrumental training on pitch discrimination in young children and providing evidence of neuroplasticity, which occurred within a relatively short period of time of instrumental training.

Although duration of musical training continued to impact cognition and brain plasticity (Wetter et al., 2009; Hyde et al., 2009; Forgeard et al., 2008), early training also positively contributed to these areas. In particular, participants who began musical training by or before age 7 had greater sensorimotor synchronization (Steele et al., 2013), maturational change of the premotor cortex (Bailey et al., 2014), positive music transfer to language skills (Strait et al., 2013b), more brainstem responses to sound (Skoe and Kraus, 2013), and neural efficiency (Vaquero et al., 2016). These studies, which focused on duration and commencement, support my hypothesis that playing the violin at an early age for at least 2 years impacts cognition. Hudziak et al. (2014) also found that early commencement of musical training made an impact on cortical thickness in brain regions involving executive function and working memory for youth who played an instrument before age 10. The following section provides more evidence linking musical training with increased executive function, attention, and working memory.

Executive Function and Working Memory

Several studies (Degé et al., 2015; Moreno et al., 2011; Nutley et al., 2013; Roden et al., 2013) involving children provided positive associations between musical training and improved executive function, attention, and working memory. Nutley et al. (2013) conducted a randomized, longitudinal study involving 330 individuals aged 6-26 to determine whether playing a musical instrument was associated with higher performance on tests of reasoning, processing speed, working memory, and mathematical and reading comprehension ability. Nutley et al. (2013) assessed participants in neuropsychological assessments and neuroimaging tests at three different points each 2 years apart. A mixed model regression showed that musical training had a positive association with working memory, processing speed, reasoning, mathematics, and larger gray matter volume in the temporo-occipital and insular cortex. In particular, Nutley et al. (2013) determined that the change in working memory was proportional to the number of hours per week spent practicing. The effect was also seen after correcting for baseline performance, parental education, and other after-school activities, including physical activity, TV-watching, and gaming. Interestingly, there was no significant association between music training and reading comprehension.

Roden et al. (2013) recruited 50 children aged 7-8 from four primary schools in Germany to test whether a music training group (*n*=25) would have more pronounced cognitive abilities related to phonological looping and executive function than a control group involved in natural science activities (*n*=25). Both groups received training over a year and a half period of time. The music group received 45-minute weekly lessons in guitar, violin, cello, flute, trumpet, keyboard, or drums in varying group size with a maximum of five students. There were no significant differences between the two groups (SES and basic cognitive functions) except that the music group had significantly higher IQ on average than the control group.

Roden et al. (2013) found that the music training group scored significantly higher in tests addressing phonological loop, specifically the One-Syllable Word Span Test and Nonword Recall Test, central executive subtests (Counting Span and Complex

Span Tests), and verbal (but not general) intelligence than the control group. According to Roden et al. (2013), “Considering the high effect sizes of all interactions in the present study, these results suggest some validation of a transfer effect from music to more specific cognitive domains including the phonological loop and the central executive components of working memory” (p. 295). These findings not only suggest that music can be used as an intervention to impact children’s auditory working memory over the course of one and a half years but also support Moreno et al. (2011) study on the positive impact music training has on executive function.

Moreno et al. (2011) recruited 64 children aged 4-6 from neighborhoods within a large city for its quasi-experimental, longitudinal study to examine whether music training would improve verbal intelligence independent of spatial intelligence, lead to rapid transfer, and improve executive function. The participants were placed into two groups and received computerized training in either music or visual arts for two daily sessions, 1 hour each, 5 days a week for 4 weeks. The computerized training of the music group (n=32) included tasks in rhythm, pitch, melody, voice, and basic musical concepts. The visual arts training included concepts related to shape, color, line, dimension, and perspective. A pre- and posttest were conducted involving measures in verbal and spatial intelligence using two subtests from the Wechsler Preschool and Primary Scale of Intelligence, as well as parent questionnaires providing background on children’s previous music and visual art training and mother’s education as an indicator of SES. After 20 days of training, Moreno et al. (2011) found that only the music group showed improved performance on verbal intelligence and that these advancements correlated with improvements in behavioral measures of intelligence and functional changes in the brain during an executive function task.

Several studies involving music instruction either found no cognitive transfer (Mehr et al, 2013), credited improved executive function task to higher IQ (Schellenberg, 2011), or found that an alternative training would perform equally (Janus et al., 2016) or outperform those involved in music training (Roden, Grube, Bongard, & Kreutz, 2014) in cognitive measures, including executive function. Mehr et al. (2013) used spatial-navigation reasoning, visual form analysis, numerical discrimination, and receptive vocabulary as measures to assess cognitive transfer from music training. Two randomized, longitudinal studies involving preschoolers aged 4 provided both a comparison group with alternate training (visual arts) and a no-training control. Mehr et al. (2013) used a MATLAB script that generated 80,000 possible groupings and a grouping with the smallest difference between groups in age, gender, ethnicity, and family income, and child vocabulary scores.

The first study conducted by Mehr et al. (2013) involved 15 preschoolers in music and 14 in painting, while the second study included 23 preschoolers in music and 22 as the control group receiving no special intervention. All of the children were recruited from Boston through flyers. The training groups participated in 6 weekly classes, 45 minutes each, focused on parent-child interaction. The music group activities included singing, recorded music, gross motor movement activities, free-form dancing, and instrument play with shakers and rhythm sticks, while the visual arts group focused on artistic play through visual arts media. Mehr et al. (2013) found no consistent evidence for cognitive transfer from music training to spatial, linguistic, or numerical reasoning.

Schellenberg (2011) also examined executive function as a mediator between music instruction and IQ, but asserted that high IQ scores, not music instruction, improved performance on executive function tasks and that children with a high IQ were inclined to take music lessons. Schellenberg (2011) recruited 54 boys and 52 girls from a middle to upper-middle class suburb of Toronto. Of the 106 participants, 50 of the participants had musical training: 9- and 10-year-olds had at least 2 years of music lessons, while 11- and 12- year-olds had at least three. The control group had no musical training except for music class in school. While the participants took the Wechsler Abbreviated Scale of Intelligence (WASI) and five executive function tests, their parents completed questionnaires regarding demographic information, including family income, parent education, parents' first language, and their child's out-of-school activities. The executive function tasks tested attention, working memory, verbal fluency, and problem solving and planning.

When the confounding variables (i.e., parent income, education, and student activities) were held constant, Schellenberg (2011) determined that the musically-trained group scored significantly higher than the untrained group across all four subsets and three IQ scores. These results offered proof that music has an overall effect on intelligence, rather than a domain-specific one. High IQ scores also correlated with better performance on the executive function tasks, but musical training was not a factor. Only in the Digit Span task, which required students to remember a sequence of numbers both forward and backward, did the musically-trained group outperform the control group. With the exception of the Digit Span task, there were no significant differences on executive function tasks between the two groups. Schellenberg (2011) attributed high IQ scores to improved performance on executive function tasks, as well as a child's inclination to take music lessons. In addition, the researcher suggested that future studies examine whether music training contributes to key school habits such as motivation, concentration, and confidence, or if highly functioning students come genetically equipped with these skills.

Roden et al. (2014) conducted a study involving 345 children aged 7-8 and contributed findings that suggest an alternative training (nonmusic) may produce cognitive measures that outperform those involved in a music training. The children were recruited from 25 primary schools in different regions of Germany. Music children were quasi-randomly selected from 63 different music classes to remove systematic school or class effects. The instrumental music class comprised 192 students and extended natural science class focusing on topics related to the school curriculum comprised 153 students. Both trainings met during the school year for 45 minutes/week over an 18-month period. The children in the music training group chose guitar, violin, cello, flute, trumpet, keyboard, or drums and were taught by public school music professionals. At baseline, there were significant differences between the groups regarding cognitive ability or SES, so both measures were treated as covariates to measure their influence. The size of the groups of children receiving music training was limited to five, whereas the natural science training involved all children in one classroom. Results from the study found that students in the natural science training had stronger increases in visual attention over time than their musical peers with a moderate effect size, while the music training group had a small effect size on higher increases in information processing.

Janus, Lee, Moreno, and Bialystok (2016) conducted a longitudinal study involving 57 children aged 4-6 who attended a 20-day summer camp with 2 daily 1-hour sessions. Children were assessed individually to ensure no pre-training differences in IQ, education, time spent playing video or computer games, musical exposure, non-English language use, and SES by mother's level of education. The children also completed measures in receptive vocabulary, nonverbal IQ, verbal fluency, and nonverbal and verbal working memory and were pseudo-randomly assigned to either a music or French-language group after being matched for age and SES.

For the music group (*n*=29), Janus et al. (2016) incorporated tasks involving rhythm, pitch, melody, voice, and basic musical concepts, while the French language group (*n*=28) completed tasks involving vocabulary learning and communication schemes. Both trainings used computer-based interventions. There were no differences in age, maternal education, vocabulary knowledge, and non-verbal cognitive functioning for either group at pre- and posttest. After training, Janus et al. (2016) found that both groups performed significantly better in three of the tasks involving executive control (verbal fluency, visual search, and grammaticality judgment) providing evidence that activities like music training effect brain plasticity and certain aspects of executive control.

Studies examining the link between music training and executive function provided mixed results. Several studies provided positive associations between musical training and improved executive function, attention, and working memory (Degé et al., 2015; Moreno et al., 2011; Nutley et al., 2013; Roden et al., 2013). The Nutley et al. (2013) longitudinal study warrants merit because of its randomized, large sample size (*n*=330). The intensity of music practicing effected the change in working memory and was proportional to the number of hours per week spent practicing. However, Nutley et al. (2013) was the only study that had a wide age range of participants, spanning 6 to 26 years.

The remaining studies collectively included children aged 4 to 11 (Janus et al., 2016; Mehr et al., 2013; Moreno et al., 2011; Roden et al., 2013, 2014; Schellenberg, 2011). Several studies involving music instruction either found no cognitive transfer (Mehr et al, 2013), credited improved executive function task to higher IQ (Schellenberg, 2011), or found that an alternative training would perform equally (Janus et al., 2016) or outperform those involved in music training (Roden et al., 2014) in cognitive measures, including executive function. Many of the students who will participate in my research study are impacted by trauma. According to Arvidson et al. (2011), trauma adversely affects executive functioning, which impacts learning. Although my research study does not measure performance in executive function, I continue to be interested in how music impacts cognitive processes that in turn improve other cognitive skills such as reading. The following section examines the impact that music training has on improved language skills related to special populations, including second language learners and students diagnosed with dyslexia.

Special Populations

Second language learners. Music training also has been used as in intervention in second language (L2) learning and special language impairment learners, including students diagnosed with dyslexia. Moreno and Lee. (2015) examined the effect that music training and second-language learning had on functional brain changes of English-speaking children. Thirty children aged 4-6 participated in this longitudinal intervention, which occurred at a 20-day summer camp with 2 daily 1-hour sessions and a 1-year follow-up. After children were assessed individually to ensure no pre-training differences in IQ, SES, formal music training, languages spoken at home, and child's second language abilities, they were pseudo-randomly assigned to either a music or French-language group. The music group (*n*=14) incorporated tasks involving rhythm, pitch, melody, voice, and basic musical concepts, while the French language group (*n*=16) completed tasks involving vocabulary learning and communication schemes. Both trainings were computerized programs. Despite the small sample size, Moreno and Lee (2015) identified from pre- and posttests with a 1-year follow-up, neuroplasticity in early childhood after a short training period in music and second-language learning (Hyde et al, 2009; Schlaug et al. 2009). Both training programs produced training-specific effects and domain-general changes supporting a bi-directional link between music and language processing.

Yang, Ma, Gong, Hu, and Yao (2014) employed a longitudinal study to determine whether long-term music training impacted academic development of first language (L1), second language (L2) and mathematics for 252 Chinese children aged 6 entering elementary school in September 2006 and followed for 11 semesters. Children were placed in either a music group (*n*=77) or nonmusic training group (*n*=173) after completing a self-report at semester 11 about their formal music training outside of school around the start of semester 3. Yang et al. (2014) found that musician children outperformed non-musician children only on musical achievement and second language development when mother's educational experience was held constant. To address the question that higher achieving children are more likely to receive music training, Yang et al. (2014) pointed out that only music and L2 development were impacted by training; no differences existed between groups on pre-training measures on L1, L2, mathematics, and IQ.

Dyslexic and special language impairment (SLI). Studies involving beat perception and rhythmic reproduction contributed to improved reading skills in children diagnosed with dyslexia. Flaugnacco et al. (2015) conducted a randomized control design testing whether music training enhanced phonological and reading abilities in children diagnosed with dyslexia. The study involved 46 dyslexic children aged 8-11 who were referred to a health unit in Rome, Italy and placed into two groups based upon pre-training assessments that matched them in sex, age, previous musical or painting experience, and SES. The music group (*n*=24) included activities based on Kodaly- and Orff-Schulwerk-based music practices while the control group (*n*=24) took painting as an alternative activity. Both classes met 2 hours per week for a 7-month period.

Flaugnacco et al. (2015) found that music training can modify reading and phonological abilities for children who are severely impaired in these areas including children with dyslexia. Even though the sample size was slightly smaller than suggested, the power on the final outcome was >0.80. Improvement in reading included test reading and pseudo-word reading, which Flaugnacco et al. (2015) stated are difficult to train. Interestingly, the best predictor of phonological awareness was rhythmic reproduction, not working memory or auditory attention. Also temporal anisochrony (or the ability to detect the regular timing of an auditory sequence) correlated strongly with musical training and phonological skills. Vocabulary and mathematical skills were not affected by music training, and the painting group had improved more than the music group in visuo-spatial abilities.

Goswami, Huss, Mead, Fosker and Verney (2013) also conducted research on beat perception as it relates to music and language, particularly phonological and prosodic structures. The study involved 88 children aged 8-14 of whom 38 were identified as dyslexic or having severe literacy and phonological deficits. Fifty-nine of them had participated in a musical study a year earlier (Huss et al., 2011). All of the students were recruited from the same schools and matched either by reading level or age. Measures included phonological awareness, phonological short-term memory, and beat perception. Goswami et al. (2013) found that the musical beat structure task was a predictor of variance in reading attainment by children.

Huss et al. (as cited in Goswami et al., 2013) found that children with dyslexia had significantly poorer ability to perceive changes in beat distribution than typically-reading same age controls, but performed at the same level as younger children with same reading level. Goswami et al. (2013) provided a year follow-up with the same participants in the Huss et al. (2011) study and found that children with dyslexic performed more poorly in sound rise time and musical beat structure than younger children reading at the same level. The musical beat structure task also proved to be a significant longitudinal predictor of reading by accounting of over half of the variance in reading comprehension and phonological awareness.

Przybylski et al. (2013) also tested whether a rhythmic intervention would have an effect on syntax processing in children with specific language impairments (SLI) and dyslexia. Sixty students aged 6-12 were involved in the two studies. Study one involved 12 SLI and 20 matched for chronological age or reading age. Study 2 involved 10 dyslexic students and 18 controlled for chronological age or reading age. For both studies, children listened to either a regular or irregular musical prime sequence, which was followed by blocks of grammatically correct and incorrect sentences. Subsequently, participants were asked to judge the grammaticality of the sentences. Przybylski et al. (2013) found that using rhythmic structures may boost linguistic structure processing.

The studies included in this section provided positive links between music training and its effect on language skills of second language learners and students diagnosed with dyslexia. In particular, beat production and rhythmic reproduction positively impacted phonological awareness (Flaugnacco et al., 2015), reading comprehension and attainment (Goswami et. al, 2013; Huss et al., 2011), and linguistic structure processing (Przybylski et al., 2015). These studies provided similar results of those listed in the Rhythm section of this Literature Review, many of which found that rhythmic training improved reading and phonological awareness skills in children without special language impairments (Bhide et al., 2013; Carr et al., 2014; Degé et al., 2015; Gordon et al. 2014; 2015; Kempert et al., 2016, Rautenberg, 2015). Since both control and treatment groups of my research study attended one of Title I schools with English language learner and special language impairment populations, the positive findings from these studies linking musical training with improved reading skills supported my research study examining violin instruction and reading achievement in first graders.

Summary

The literature in this chapter examined the role that instrumental music plays for young children in cognition, brain development, and academic achievement, particularly in the area of language and reading. Many of the studies were conducted at El Sistema programs in the United States, which served disadvantaged youth through ensemble-based instruction. These studies contribute to music as a vehicle for social change through the impact that music training has on brain plasticity, improved academic achievement, and development of literacy skills, including phonological awareness, auditory processing, speech segmentation, and reading.

Duration and commencement of music training also played important roles in the results of several studies. Slater et al. (2014) found that students participating in a music class for 1 year outperformed their untrained peers on standardized reading measures. Kraus et al. (2014b) and Holochwost et al. (2017) found that only children who participated in at least 2 years of music lesson showed improvement in neural differentiation of syllables and academic achievement, respectively, while Chobert et al.

(2014) identified a minimum of 6 months of music training necessary to improve acoustic and phonological cues of young children. Even though the studies matched their intervention and control groups for confounding variables (i.e., gender, SES, and maternal education), small sample size, pseudo-randomly assigned groups, and studies drawing from the same participant group are a few reasons why future studies are needed to determine whether instrumental music impacts reading achievement in young children.

The research study that I conducted addressed several of the gaps found in the literature by including a larger sample size and including students with low SES. My study could help confirm a link between music instruction and reading skills with a sample size of 38 students in first grade who played the violin for 2 school years over a 70-week period. The data collected from this longitudinal study also could contribute to the link between increased duration of instrumental instruction and academic achievement (Chobert et al., 2014; Krauss et al., 2014b; Slater et al., 2014), which would provide support for the expansion of my social change proposal to all grades, K-12. The next chapter details the research method and design of my study.

Chapter 3: Research Method

The purpose of this quasi-experimental study was to test Vygotsky's sociocultural cognitive theory that playing a musical instrument is significantly associated with academic achievement in reading for first graders who attended one of two schools in Alaska. To ensure confidentiality, the school district in which the two elementary schools reside will be referred to as the Alaskan School District throughout this dissertation. This chapter details the research design, rationale, methodology, instrumentation, and materials used to examine this quasi-experimental study. In addition to addressing threats to validity, this chapter outlines the sample and effect sizes, procedures followed to ensure ethical practices, and a statistical analysis plan. A summary concludes the chapter.

Research Design and Rationale

For this study, I used the nonequivalent control group design, which is widely used in educational research. According to Campbell and Stanley (2015), the nonequivalent control group design "involves an experimental group and a control group both given a pretest and posttest, but in which the control group and the experimental group do not have pre-experimental sampling equivalence" (p. 47). This design choice is consistent with research designs needed to advance knowledge in the discipline of instrumental music and academic achievement because the treatment and control groups of this study occur naturally through classrooms at Title I schools with similar demographics, yet all of the students at one school received violin instruction during school hours, while the other school students did not.

The research question is: What is the relationship between instrumental music and academic achievement on MAP reading scores of first graders who received at least 90 minutes per week of violin instruction for 2 consecutive years at a Title I School? The covariate is defined as reading scores on the MAP assessment for kindergartners in fall 2013 (pretest), and the dependent variable is MAP reading scores in spring 2015 for the same students as first graders (posttest). The independent variable is defined as 90 minutes per week of violin instruction for 70 weeks administered during the 2013-2014 and 2014-2015 school years. The intervening variables are defined as individual classroom teachers and their varying approaches to reading instruction, although both schools implement the same reading program. This study had no time or resource constraints because I used archival MAP data.

Researchers face the challenge of attaining both internal and external validity when designing their studies. A research study should reflect both a representative population in a real-world setting while establishing causation by isolating an independent and dependent variable. According to Frankfort-Nachmias and Nachmias (2008), no design can adequately accomplish both types of validity and, therefore, researchers tend to consider internal validity more crucial than external validity. The experimental design establishes internal validity through three key components: Comparing, manipulating, and controlling variables.

Only the quasi-experimental and cross-sectional designs more adequately address the fourth component of research design, generalizability, which is the extent to which the results of a study can apply to different settings or larger populations. I chose a quasi-experimental design for my research study because the control and treatment groups were determined by classroom and school without random assignment. According to Frankfort-Nachmias and Nachmias (2008), "Ethical considerations and issues of practicality sometimes prevent the random assignment of research participants to the experimental and control groups in social science research" (p. 95). The only way that I could establish a random sample for this research study was to provide some and not all of the first graders violin instruction at the designated Title I school. Ethically, as the school's music teacher, I could not consider denying some students violin lessons, especially since many of the students' families do not have the financial means to pay for private lessons on their own. A quasi-experimental design allows me to offer violin instruction to all of the first graders, free of charge, while determining a control group of similar first-graders at a nearby Title I elementary school, where violin instruction is not provided. This was a longitudinal study because I gathered data for the same subjects over an extended period of time. The participants formed a convenient sample naturally grouped by classroom, grade, and school.

Methodology

This section details the research methods used to address my quantitative study. The topics include population, sampling and sampling procedures, additional information concerning intervention and archival data, instrumentation and operationalization of constructs, and data analysis plan. Topics specific to my longitudinal study are intervention and archival data.

Population

The target population for this study was 76 students from two Title I schools in Alaska who consistently attended their schools from kindergarten through first grade during the 2013-2014 and 2014-2015 school years. The population was predetermined because it involved students naturally grouped in classrooms at two Title I schools with similar demographics. At one school, three classes of students received 90 minutes of violin instruction per week during school hours.

The site of this experimental group was purposively selected to fill a gap in previous research (e.g., Hyde et al., 2009; Rauscher & Hinton, 2011), which lacked participants from low SES families or music programs accessible to all students during the school day. A study at a Title I school in which 39% of the population are eligible for FRL and where all of the kindergartners and first graders receive intensive violin instruction as part of their school day could help address this gap in the research. Each grade level had three classes of approximately 25 students each.

To serve as the control group, I selected the first grade classes at two schools with similar demographics. According to Frankfort-Nachmias and Nachmias (2008), “By using a control group, the researcher controls most of the intrinsic factors that could threaten the validity of the experiment” (p. 101). Although participants were in different classrooms, both sites used the same reading and math programs and shared similar demographics and SES. The use of a pre- and posttest helped address the intrinsic factor of maturation, which recognizes that individuals mature at different times.

Sampling and Sampling Procedures

The selection process for participants involved a convenience sample as students already were grouped by class and school. The sample included students 5–7 years of age. The two schools are within 11 miles of each other and shared similar demographics and SES. The Title I school with the violin intervention had 39% of students eligible for FRL versus 37% of the other school, but both had 5% ELL. The school with the treatment group had 32% Alaska Native students and 15% of its students receiving special needs services, while the school with the control group had 23% and 20%, respectively. Forty-five first graders at each school comprised the treatment and control groups.

MAP reading scores for both fall 2013 and spring 2015 only were available for 38 students at the control site and 40 students at the treatment site. These numbers were further reduced when outliers were removed during the data screening process bringing the sample to 38 cases for both control and treatment groups. The majority of students at both school sites were white. Because too few cases were represented in the other ethnicity categories, I combined the following to create a category termed Other, which included Hispanic, Asian, American Indian, Alaska Native, Multi-ethnic, African-American, and Pacific Islander/Hawaiian Americans. From prior standardized test results, the Alaskan School District determined that students who had demographic categories of FRL, ELLs, IEPs, and/or AK tended to have lower test scores. This study also had few students eligible in each of these categories. As a result, I combined them to create a category termed at-risk.

With the unexpected smaller sample size of 38 for both control and violin groups, I computed a large effect size of Cohen's f = .48 to achieve 80% power, alpha = .05. I used the free software program, G*Power (Heinrich-Heine-Universität Düsseldorf, 2017) to help determine the effect. I selected the ANCOVA, fixed effects, main effects factors, and interaction *F*-test in G*Power by inputting the following statistics:

- α err probe: 0.05
- Power: 0.8
- Total sample size 36
- Numerator df: 1
- Number of groups: 2 (control and intervention group)
- Number of covariates: 1 (pre-test)

The resulting effect size *F* was 0.48. The music studies I examined used similar sample sizes. Roden, Kreutz, and Bongard (2012) conducted a repeated measures ANOVA, within-between interactions analysis and examined the impact of a school-based instrumental music program on the development of verbal and visual memory skills for students aged 7 and 8. Over a period of 18 months, 73 students participated in one of the following weekly 45-minute sessions: Instrumental music lessons or natural science training.

Seven other music studies involving elementary school children (Bhide et al., 2013; Chobert et al., 2014; Francois et al., 2013; Habibi et al., 2014; Kaviani et al., 2014; Kraus et al., 2014a, 2014b, 2014c; Slater, 2014) had sample numbers ranging from 19 to 60 participants with a mean of 39 and mode of 42. Also, in *Practical Statistics for*

Educators, Ravid (2011) recommended, "A sample size of at least thirty cases or subjects is recommended in most studies in education" (p. 29). With these numbers as examples, I felt confident that I could narrow my sample population to include only those students who had been in the violin program for 2 years (intervention group) and those who had attended both kindergarten and first grade at the control school without sacrificing effect size.

The weaknesses of my sampling strategy derived from the use of a convenient sample where participants were naturally grouped by class, grade, and school. Although many educational studies use convenience samples, this type of design makes it difficult to establish internal validity because participants are not randomly assigned. The strengths of my sampling strategy are the measures that I put in place to help offset threats to internal validity posed by the use of a convenience sample. Those measures included choosing kindergarten and first grade classrooms at schools with comparable demographics and applying a frequency distribution to ensure that both intervention and control groups had similar percentages of relevant characteristics (e.g., gender, ethnicity, and free and reduced lunch eligibility). Also, checking against several sources, I felt confident that I had a large enough sample size to demonstrate a real treatment effect.

Intervention

The experimental treatment at one of the Title I schools was an El Sistema-inspired violin program for all kindergartners and first graders, which provides instrumental training 90 minutes/week for 35 weeks each year during school hours. Using various music pedagogies, including Suzuki, El Sistema is an approach to music education originating from Venezuela that provides intensive performance training and peer-teaching through ensemble from early childhood to adulthood. Music preparation is geared toward performing in orchestra and folk ensembles, so instruction involves the entire classroom.

During the first three months of kindergarten, students practice on a cardboard violin that parent and child build together during the first week of school at an evening event. These cardboard violins are used to develop respect, care, and discipline for the stringed instrument that the child will eventually play. The paper instruments also allow children to safely practice motor skills needed for bowing and handling before the real instrument is placed in their hands. By the end of first grade, students could identify simple rhythms and notes on D and A strings, perform folk tunes including Twinkle, Twinkle Little Star, Bile Them Cabbage Down, Ode to Joy, and Mary Had a Little Lamb. Students sang the songs before playing them and were encouraged to take leadership roles through peer-mentoring. As the school music teacher, I co-teach each kindergarten violin class with the classroom teacher and a local string teaching artist with the first grade classrooms.

Archival Data

With the permission of the Alaskan School District, this study used secondary data in the form of kindergarten and first grade MAP reading scores to compare the scores of the intervention group with those of the control group. The Assessment and Evaluation Director of the Alaskan School District used the school district's software program, PowerSchool, to provide me each participant's demographic information. Since

PowerSchool already assigns specific numerals and letters to code these categories, I used the same coding system for conformity and uniformity. I obtained both a signed Data Use Agreement and Letter of Cooperation from the school district superintendent (Appendix A and B).

Instrumentation and Operationalization of Constructs

MAP is a computerized adaptive test that measures students' academic performance and growth in mathematics, reading, and language usage. Three times a year (fall, winter, and spring) the school district administers MAP testing for all its students in kindergarten through tenth grade. The Northwest Evaluation Association (NWEA) developed MAP testing in 2000.

My decision to use MAP tests scores is grounded in the test's relevancy to the Alaskan School District, generalizability, validity, and reliability. The Alaskan School District has used MAP testing and data for over 10 years as a formative assessment for tracking students' academic growth. NWEA provides tools, like MAP testing, for over half the schools in the U.S. (NWEA, 2017), which lends itself to generalizability. The opportunity for similar studies to be conducted in different schools, geographic locations, and demographics is more likely to occur when these studies use common testing formats. The El Sistema-inspired violin program in Alaska is one of many similar programs emerging throughout the United States, many of which are serving Title I students in public schools (El Sistema USA, 2017b).

The MAP for Primary Grades assessments are designed for kindergarten through first grade, include tests in reading and mathematics, and average 40 minutes per student or group. These tests display interactive elements, provide audio for beginning readers, and use four item types: Multiple choice and “hot spot” items ask students to choose one or more answers from a prescribed set, while “sticky click”, and “click and pop” items require student to create or place manipulatives in an order to complete a response. MAP scores are reported as Rasch units (RIT) ranging from 100 to 300 (American Institutes for Research, n.d.). According to NWEA (2015), MAP RIT Scale Norms were based on samples from kindergarten to eleventh grade, comprising of “72,000 to 153,000 student test records from approximately 1000 schools…These samples were drawn randomly from test record pools of up to 10.2 million students attending more than 23,500 public schools spread across 6,000 districts in 49 states” (p. 2). These rigorous procedures establish validity and reliability for MAP testing and status norms for reading in kindergarten and first grade students at begin-, mid-, and end-year points.

Table 1

MAP Score Status Norms in Reading for Grades K-2

2015 Reading RIT Scale Norms						
	Begin-Year		Mid-Year		End-Year	
Grade	Mean	SD	Mean	SD	Mean	SD
K	141.0	13.54	151.3	12.73	158.1	12.85
1	160.7	13.08	171.5	13.54	177.5	14.54
2	174.7	15.52	184.2	14.98	188.7	15.21

Note. From Northwest Evaluation Association (2015). *2015 NWEA Measures of Academic Progress normative data*. Retrieved from https://www.nwea.org/resources/2015-normative-data/

Operationalization

RIT is also the achievement scale that NWEA uses as an equal interval-based measurement tool to score each student's performance and measure growth over time. The difference between the scores does not change, no matter where the student is on the scale or what grade level. Scales lend themselves to statistical analysis, including nominal, ordinal, and interval levels of measurement. Unlike indexes, which are an accumulation of scores, scales "reflect a single dimension and can be placed on a continuum presumed to apply to one and only one concept" (Frankfort-Nachmias & Nachmias, 2008, p. 415). Scales serve as a reliable and valid measuring tool because of this principle of unidimensionality.

MAP was developed by NWEA to test content that reflects state-specific and national curriculum standards. The level of test questions adapts to the ability of each individual child: Correct answers prompt more challenging test questions while incorrect answers, less complex. Tailored to reflect both Alaska state standards and national curriculum, MAP offers opportunities for testing other populations and conducting longitudinal studies to measure growth over time.

Data Analysis Plan

The research question for this study is: What is the relationship between instrumental music and academic achievement on MAP reading scores of first graders who received at least 90 minutes per week of string instruction for 2 consecutive years at a Title I school? The null hypothesis is there is no significance between the MAP reading scores of students receiving 2 consecutive years of string instruction and students receiving no string instruction. The alternative hypothesis is there is a significance between the MAP reading scores of students receiving string instruction and students not receiving string instruction. SPSS Version 21 was used to conduct an ANCOVA, main effects and interactions, to measure the dependent variables of MAP reading scores of first graders and MAP kindergarten reading scores as the covariate (pretest).

Because ANCOVA is a linear model the same assumptions that must be met for ANOVA tests apply for ANCOVA including normality, linearity, homogeneity of variance, and data cleaning to address outliers (Laureate Education, Inc., 2009). In addition to these assumptions, Field (2013) included two assumptions specific to ANCOVA: Homogeneity of regression slopes and independence of the covariate and experimental condition. Other assumptions that needed to be met were normality of variables (no skewness or kurtosis) and the trimming of extreme outliers that could reduce the generalizability of the results (Laureate Education, Inc., 2009).

Only scores from students who had been in the violin program for 2 years (intervention group) or who had attended both kindergarten and first grade (without interruption) at the control site were included in the analysis. Students who had an attendance rate of less than 70% during the 2013-2014 and 2014-2015 school years were excluded from both groups. The pretest coincided with the administering of the fall MAP test, which occurred before the kindergartners participated in the violin program. The following steps and statistical analyses were implemented:

1. Computed and reviewed descriptive statistics for variables in the data set, including the dependent variables (sets of MAP scores), and the independent

variable of interest (violin study during school hours), and sample demographic data (gender, ethnicity, FRL, and ELL).

2. Before conducting ANCOVA, verified the assumptions of an ANCOVA including normality, linearity, homogeneity of variance, and data cleaning to address outliers. In addition to these assumptions, tested for homogeneity of regression slopes and independence of the covariate.
3. Conducted ANCOVA using kindergarten MAP reading scores fall 2013 as the covariate, first grade MAP reading scores spring 2015 as the dependent variable and the following as fixed factors: Group, gender, ethnicity, and at-risk. Ran a full-factorial analysis and selected the bootstrap option to ensure that the results derived from robust estimates of standard errors and confidence intervals.
4. Interpreted the results by reporting whether a significant correlation existed between the independent variable (violin) and the dependent variable (MAP reading scores of first graders). The null hypothesis was rejected. Provided an explanation of why the results occurred and implications for future studies. Results were reported in tables including F ratios, degrees of freedom, p values, effect sizes, and a 95% confidence interval for the main effect of each factor, their interactions, and covariate.

Threats to Validity

The archival data used in this study was generated by NWEA through MAP and have proven to be a valid and reliable instrument. Frankfort-Nachmias and Nachmias (2008) warned that the difference in pre- and posttests is not necessarily due to the intervention, but rather to the student's experience of retaking the test. MAP assessments address this threat to external validity by conducting test-retest reliability, which ensures that the "second test (or retest) is not the same as the pre-test. The second test is one that is comparable to the first, by virtue of its content and structure, differing only in the difficulty level of its items" (NWEA, 2004, p. 1). A pretest in September 2013 and a posttest in May 2015 was proctored by a school administrator or teacher who was trained in MAP testing procedures.

The limitations of using MAP testing as the measurement tool for this study relates to content validity. The risk in using secondary data is that it may only approximate the kind of data needed to test a hypothesis (Frankfort-Nachmias & Nachmias, 2008). Since I used a quasi-experimental design, threats to internal validity were already present because my study lacked a random sample. I considered the inclusion of a standardized measuring tool that had been evaluated for validity and reliability by an outside source a positive step toward rectifying this issue.

Although both schools have a transient population, children who moved in and out of either school site during their kindergarten or first grade year were eliminated from the study to avoid experimental mortality. I only included in my study the scores of students who had been in the violin program for 2 years (intervention group) and students who had attended both kindergarten and first grade (without interruption) at the control site. The pretest coincided with the administering of the fall MAP test, which occurred before the kindergartners participated in the violin program.

Controlling characteristics for the two groups helped contribute to intrinsic factors of validity and focused the study on the effectiveness of the intervention. The goal of this study was to help fill a gap in previous research in which treatment samples came from either upper income families and/or attended after-school music lessons. Those intervening variables challenge a study's internal validity and introduce the possibility of a spurious relationship. Frankfort-Nachmias and Nachmias (2008) defined a spurious relationship as one seemingly valid between the independent and dependent variables "but is actually explained by variables other than those stated in the hypothesis" (p. 527). Although participants are in different classrooms, they had been matched by age, demographics, and income level. Also both school sites used the same reading and math programs, which could help minimize an internal threat of history.

Construct Validity

Danish mathematician, George Rasch, (1901-1980) developed the RIT scale, which NWEA uses as a form of concurrent validity or parallel form of reliability for its MAP testing. Rather than measure populations, Rasch focused on individual characteristics independent of the item response to a test question. Item and person are measured independently. Rasch then used probability statistics to measure what the likelihood would be for a person with specific traits to answer correctly an item of a certain difficulty.

Rasch aligned his model with the purpose of MAP testing, which is to accurately measure a student's growth and performance independent of a sample population. According to Randich (as cited by Panayides, Robinson, & Tymms, 2010) Rasch's model is a unique approach concerning data-model relationships because it allows the data to describe the model rather than vice versa. By using Rasch's RIT scale and item response theory, MAP testing ensures that student's responses to test items are measured independently of how other students performed on similar test items.

Reliability of the Measurement

Researchers must not only align their design and measurement tools to ensure construct, content, and empirical validity, but they must also accurately identify and represent the population they are studying. Research in the social sciences is complex. It involves the study of human nature and society, which often means that a dependent variable is an attitude or the interaction of multiple variables is part of the equation. According to Frankfort-Nachmias and Nachmias (2008), researchers use scales to combine several variables into a single score, which helps address the challenges of complex data.

NWEA (2012a) lists additional reasons for using the RIT scale including stability over time, grade independence, and accuracy based upon "over 24 million assessments given over our 30+ years" (para. 4). MAP testing occurs during the fall, winter, and spring of each school year, which allows for test/retest reliability. Frankfort-Nachmias and Nachmias (2008) warned that the difference in a pre- and posttest do not necessarily represent the impact of the intervention, but rather the student's experience of retaking the test. To address this reliability concern, NWEA uses parallel tests that are the same in content and structure, but different in types of questions (NWEA, 2004).

Criterion, Norm, or Standards-Referenced Test

MAP tests are standards-referenced tests designed to assess student learning related to state and national standards. The Alaskan School District also uses MAP as a norm-referenced test to compare the RIT scores of its students with the national average in reading, math, and language use to establish if students are grade-level proficient. The Alaskan School District defined grade-level proficiency as "performance at or above the grade specific end-of-year 5^{th} Stanine or 40^{th} percentile based on the 2008 normative study conducted by Northwest Evaluation Association" (2011, p. 3).

Measurement Strengths and Limitations

According to Frankfort-Nachmias and Nachmias (2008), researchers use secondary data more frequently for financial, methodological, and conceptual reasons. These same three reasons underlie my choice to use secondary data, as well. Conceptually, secondary data allowed me to search through larger amounts of data taken over longer periods of time. I had the capacity to increase sample size and representation of population, which are both extrinsic factors that help validate a study's ability to generalize. The use of secondary data also makes it financially feasible for other researchers to replicate the study in a different context. I had permission to access the Alaskan School District's MAP data at no cost.

Ethical Concerns

Throughout this research study, I used ethical procedures to collect and analyze student data. Before conducting this longitudinal study, I acquired the permission of the Alaskan School District to use its MAP data and submitted my research proposal to an

Institutional Review Board to ensure that issues of informed consent, special needs of vulnerable populations (minors), and confidentiality all had been appropriately addressed.

I obtained a signed letter of cooperation and approval from the Superintendent of the Alaskan School District to obtain the MAP reading test scores and PowerSchool student demographic information for the 2013-2014 and 2014-2015 school year. Because the data was anonymous and collected through secondary sources (NWEA and the Alaskan School District Assessment Office), ethical concerns related to recruitment, data collection, confidentiality, informed consent, and harm to participants were not issues faced by this research study.

Using secondary data also removed the researcher from the initial data collection process. As a music teacher, creator of the violin program, and researcher of this study, using secondary data ensured that my biases did not compromise the validity of the data collection or analysis. Ethically, as the school's music teacher, I could not consider denying some students violin lessons, especially since many of the students' families do not have the financial means to pay for private lessons on their own. This was one reason why I did not use a random sample for this research study. According to Frankfort-Nachmias and Nachmias (2008), "Ethical considerations and issues of practicality sometimes prevent the random assignment of research participants to the experimental and control groups in social science research" (p. 95). A quasi-experimental design allowed me to offer violin instruction to all kindergartners and first graders, free of charge, while determining a control group of similar first graders at the nearby Title I elementary school, where violin instruction was not provided.

Summary

This research study used archival data as the data source for a quasi-experimental study. With permission from the Alaskan School District, this study used secondary data to compare the scores of the treatment group against the control group using standardized test scores in reading for first graders. I used the standardized assessment, MAP, as my testing and instrumentation method for the 2013-2014 and 2014-2015 school years. To complete my data analysis, I conducted ANCOVA to answer the research question: What is the relationship between instrumental music and academic achievement on MAP reading scores of first graders who received at least 90 minutes per week of string instruction for 2 consecutive school years at a Title I school? As part of the data analysis, I conducted descriptive analyses on demographic information. The results of these analyses are detailed in Chapter 4.

Chapter 4: Results

The purpose of this quasi-experimental study was to test Vygotsky's sociocultural cognitive theory that playing a musical instrument is significantly associated with academic achievement in reading for first graders who attend one of two schools in Alaska. The research question for this study is: What is the relationship between instrumental music and academic achievement on MAP reading scores of first graders who received at least 90 minutes per week of string instruction for 2 consecutive school years at a Title I school? The null hypothesis is there is no significance between the MAP reading scores of students receiving 2 consecutive school years of string instruction and students receiving no string instruction. The alternative hypothesis is there is a significance between the MAP reading scores of students receiving string instruction and students not receiving string instruction. This chapter details the data collection process, baseline descriptive and demographic characteristics of the sample, treatment fidelity, and results. A summary concludes the chapter.

Data Collection

Since this study used archival data involving standardized test scores, the data was collected by the Alaskan School District, which receives test score data from NWEA and houses student demographic information in PowerSchool. I received password-protected electronic Excel files from the Assessment and Evaluation Director in December 2017. The MAP reading scores originally were generated by the Assessment and Evaluation Department in November 2013 and May 2015. My data collection process followed my original plan with one exception: The data contained files of all students who attended either the control or treatment school during the 2013-2014 and 2014-2015 school year as a kindergartner and/or first grader, respectively, not just those who had consistently attended both years. As a result, I removed from the data set cases that had missing data for either the fall 2013 or spring 2015 MAP reading scores.

Baseline Descriptive and Demographic Characteristics of the Sample

The total population of students attending either the control or treatment school as a kindergartner in 2013-2014 or first grader in 2014-2015 was 142 students: 57 students attended the control school and 85 attended the treatment school where all kindergartners and first graders received violin instruction (see Table 2). Few cases were represented in ethnicity categories outside White. As a result, I combined the following categories to create a category termed Other: Hispanic, Asian, American Indian, Alaska Native, Multi-ethnic, African-American, and Pacific Islander/Hawaiian Americans.

Table 2

Baseline Demographic Characteristics of the Population

	Control (*n*=57)		Treatment (*n*=85)	
Variable	*n*	%	*n*	%
Gender				
Male	28	49.1	43	50.6
Female	29	50.9	42	49.4
Ethnicity				
White	35	61.4	38	44.7
Other	22	38.6	47	55.3
Free Reduced Lunch (FRL)				
Yes	13	22.8	31	36.5
No	44	77.2	54	63.5
English Language Learner (ELL)				
Yes	4	7.0	3	3.5
No	53	93.0	82	96.5
Special Education Status (IEP)				
Yes	9	15.8	14	16.5
No	48	84.2	71	83.5

MAP reading scores for both fall 2013 and spring 2015 were only available for 38 students at the control site and 40 students at the treatment site. These numbers were further reduced when two outliers were removed during the data screening process, bringing the sample to 38 cases in the control group and 38 in the treatment group.

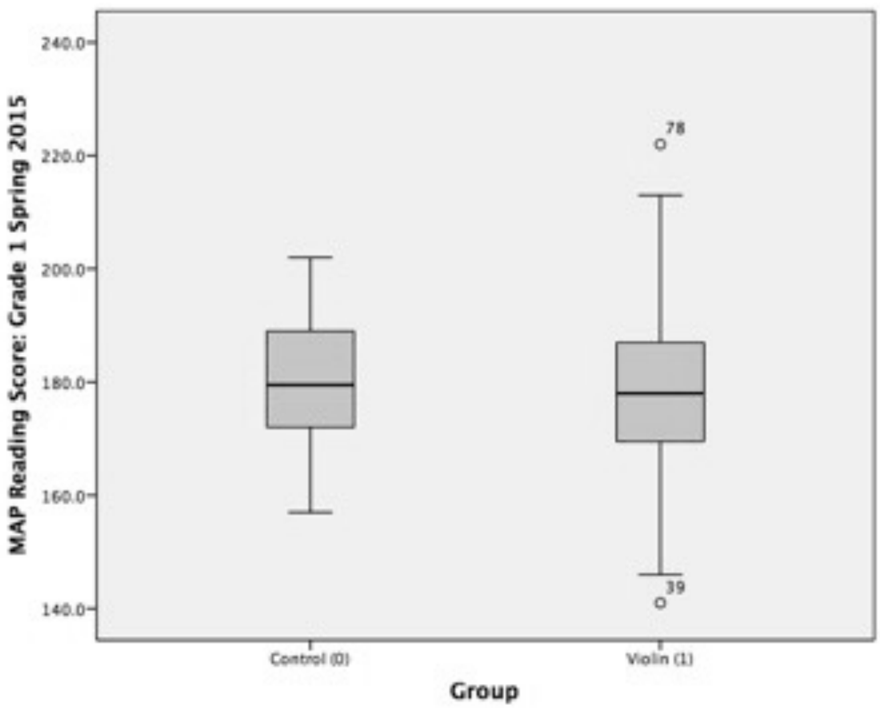

Figure 1. Box plots of MAP reading scores: Grade 1 spring 2015, control and violin groups

The sample was fairly proportional to the larger population for both control and violin groups in categories of gender, ethnicity, and FRL (see Table 3). The only compromised categories were those of which had very few cases in the population: The violin group lost all three cases of ELL students and the control group lost six of nine IEP cases while violin lost six of fourteen. From prior test results, the Alaskan School District determined that students who had demographic categories of FRL, ELLs, IEPs, and/or AK tended to have lower test scores. This study also had few students eligible in each of these categories. As a result, I combined them to create a category termed At-Risk (see Table 4).

Table 3

Baseline Demographic Characteristics of Sample: Missing Cases and Outliers Removed

Variable	Control (*n*=38)		Treatment (*n*=38)	
	n	%	*n*	%
Gender				
Male	18	47.4	19	50.0
Female	20	52.6	19	50.0
Ethnicity				
White	26	68.4	18	47.4
Other	12	31.6	20	52.6
Free Reduced Lunch (FRL)				
Yes	7	18.4	12	31.6
No	31	81.6	26	68.4
English Language Learner (ELL)				
Yes	4	10.5	0	0
No	34	89.5	38	100
Special Education Status (IEP)				
Yes	3	7.9	6	15.8
No	35	92.1	32	84.2

Table 4

Baseline Demographic Characteristics of Sample with At-Risk Category

Variable	Control (*n*=38)		Treatment (*n*=38)	
	n	%	*n*	%
Gender				
Male	18	47.4	19	50.0
Female	20	52.6	19	50.0
Ethnicity				
White	26	68.4	18	47.4
Other	12	31.6	20	52.6
At-Risk (AK Native, ELL, FRL, IEP)				
Yes	15	39.5	22	57.9
No	23	60.5	16	42.1

Intervention Fidelity

The experimental treatment at one of the Title I schools was an El Sistema-inspired violin program, which provides all kindergartners and first graders violin instruction 90 minutes/week for 35 weeks per year during school hours. During the 2013-2014 and 2014-2015 school year, this instruction was provided with fidelity. As the school music teacher, I co-taught each kindergarten violin class with the classroom teacher and in the first grade classrooms with a local string teaching artist. During the first three months of kindergarten, students practiced on cardboard violins and then performed on them for the community before transitioning to real violins. By the end of first grade, students could identify simple rhythms and notes on D and A strings, perform folk tunes including Twinkle, Twinkle Little Star, Bile Them Cabbage Down, Ode to Joy, and Mary Had a Little Lamb. Students sang the songs before playing them and were encouraged to take leadership roles through peer-mentoring.

Descriptive Statistics

To ensure that the distribution of scores did not significantly differ from a normal distribution, I conducted a Kolmogorov-Smirnov and Shapiro-Wilk Test of Normality (see Table 5). The tests generated nonsignificant values greater than .05 for first grade MAP reading scores, indicating that the first grade MAP reading scores were normally distributed for both control $D(38) = 0.086$, $p = .200$ and violin group $D(38) = .119$, $p = .189$. Since the found *p*-values are greater than the chosen alpha level, then the null hypothesis is retained. Therefore, the samples are from a normally distributed population.

Table 5

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
MAP Reading Score: Grade 1 Spring 2015	Control	.086	38	.200*	.984	38	.858
	Violin	.119	38	.189	.979	38	.682

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Descriptive statistics for the control group and the treatment groups had skewness and kurtosis, but none of these found values were large enough to be of concern (see Table 6). Even if it were a concern, I had a control and treatment group of over 30 cases, which indicates that the central limit theorem applies and will have a normal distribution "regardless of the shape of the population, parameter estimates of that population" (Field, 2013, p. 170).

Table 6

Descriptives

	Group			Statistic	Std. Error	Bootstrap[a]			
						Bias	Std. Error	95% Confidence Interval	
								Lower	Upper
Grade 1 Posttest	Control	Mean		180.474	1.7637	-.030	1.783	177.057	183.973
		95% Confidence Interval for Mean	Lower Bound	176.900					
			Upper Bound	184.047					
		5% Trimmed Mean		180.582		-.081	1.867	176.889	184.269

(*table continued*)

	Median		179.500		.309	1.641	176.025	184.000
	Variance		118.202		-2.237	24.257	70.427	169.976
	Std. Deviation		10.8721		-.1632	1.1339	8.3921	13.0375
	Minimum		157.0					
	Maximum		202.0					
	Range		45.0					
	Interquartile Range		17.0		-1.4	3.6	8.8	22.5
	Skewness		.013	.383	.020	.273	-.491	.567
	Kurtosis		-.427	.750	.008	.456	-1.147	.628
Violin	Mean		178.974	2.4095	-.017	2.494	174.184	184.053
	95% Confidence Interval for Mean	Lower Bound	174.092					
		Upper Bound	183.856					
	5% Trimmed Mean		178.810		-.012	2.562	174.000	184.003
	Median		178.000		-.218	3.070	172.500	183.987
	Variance		220.621		-7.655	51.627	120.342	319.674
	Std. Deviation		14.8533		-.3705	1.7934	10.9700	17.8794
	Minimum		146.0					
	Maximum		213.0					
	Range		67.0					
	Interquartile Range		17.3		.4	3.4	11.5	26.0
	Skewness		.250	.383	.003	.342	-.380	.944
	Kurtosis		.316	.750	-.018	.640	-.727	1.891

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Assumptions of Analysis of Covariance (ANCOVA)

ANCOVA is a multiple regression model that includes three or more conditions and controls the effect that a covariate can have on the experimental outcome. According to Field (2013), there are two reasons for including covariates: Reducing within-group error variance and eliminating a confounding factor that can compromise the true effect of the experimental condition. Because baseline tests often have a strong link to subsequent measures, pretest scores are controlled and identified as a covariate to remove variation or noise not relevant to the study. To test the effect of pretest MAP reading scores on first grade posttest scores, I conducted a basic univariate analysis with Group as the independent variable and first grade MAP reading scores as the dependent variable (see Table 7). Levene's Test of Equality of Error Variances was not significant (p = .126), indicating that the group variances were equal (see Table 8). In the Tests of Between-Subject Effects (see Table 7) results indicated the group had no significant effect on first grade posttest, p = .617. Consequently, the total amount of variation to be explained was immaterial, but an examination of the partial eta squared revealed that the variance accounted for .003 or .3%.

Table 7

Tests of Between-Subjects Effects Dependent Variable: Grade 1 Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	42.750[a]	1	42.750	.252	.617	.003
Intercept	2454845.803	1	2454845.803	14490.436	.000	.995
Group	42.750	1	42.750	.252	.617	.003
Error	12536.447	74	169.411			
Total	2467425.000	76				
Corrected Total	12579.197	75				

a. R Squared = .003 (Adjusted R Squared = -.010)

Table 8

Levene's Test of Equality of Error Variances, Dependent Variable: Grade 1 Posttest

F	df1	df2	Sig.
2.391	1	74	.126

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

When I included the pretest as a covariate in the univariate analysis, results (see Tables 9 and 10) indicated that the MAP pretest data was significantly related to the first grade posttest data with a found *p* = .004. The pretest accounted for .490 or 49.0% of the variance in the first grade posttest.

Table 9

Levene's Test of Equality of Error Variances, Covariate: MAP 2013, Dependent Variable: Grade 1 Posttest

F	df1	df2	Sig.
2.314	1	74	.132

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + MAP_Reading_Fall2013 + Group

Table 10

Tests of Between-Subjects Effects, Covariate: MAP 2013, Dependent Variable: Grade 1 Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6188.688[a]	2	3094.344	35.347	.000	.492
Intercept	815.777	1	815.777	9.319	.003	.113
MAP_Reading_Fall2013	6145.938	1	6145.938	70.206	.000	.490
Group	13.667	1	13.667	.156	.694	.002
Error	6390.509	73	87.541			
Total	2467425.000	76				
Corrected Total	12579.197	75				

a. R Squared = .492 (Adjusted R Squared = .478)

Presentation of the ANCOVA Results

ANCOVA is a linear model, which means the same assumptions that must be met for ANOVA tests apply to ANCOVA including normality, linearity, homogeneity of variance, and data cleaning to address outliers (Laureate Education, Inc., 2009). In addition to these assumptions, Field (2013) included two assumptions specific to ANCOVA: Independence of the covariate and experimental condition and homogeneity of regression slopes, which necessitates that the relationship between the dependent variable and covariate remains the same in both control and violin groups. To check assumptions of normality and linearity, I produced boxplots and histograms graphs showing the normal curve, Q-Q plot graphs for linearity, and descriptive statistics by group. Figure 2 shows the boxplots for the data after the extreme outliers were removed from the violin group. The boxplot for MAP reading scores for first grade spring 2015 indicated case 76 (see Figure 2) as a mild outlier, yet the histograms show a fairly normal distribution (see Figure 3). The Q-Q plot supports this view because the data points fall fairly close to the diagonal line (see Figure 4).

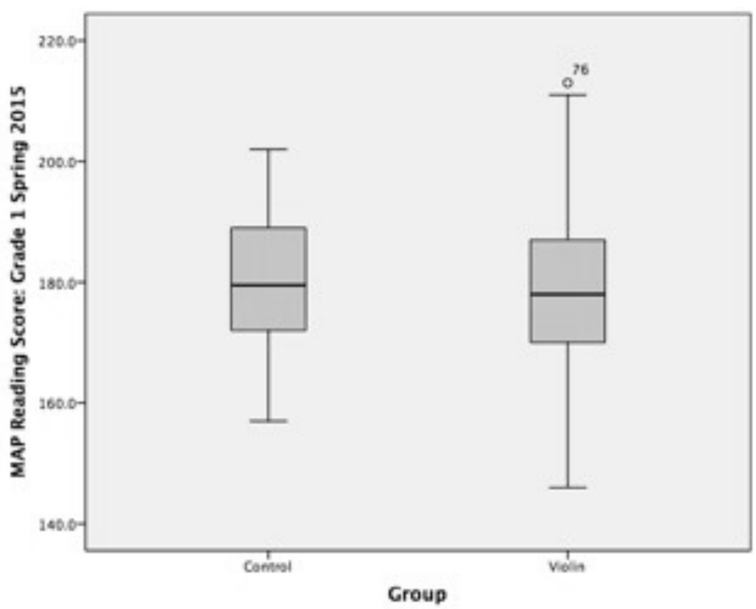

Figure 2. Box plots of MAP reading scores with outliers removed: Grade 1 Spring 2015, control and violin groups

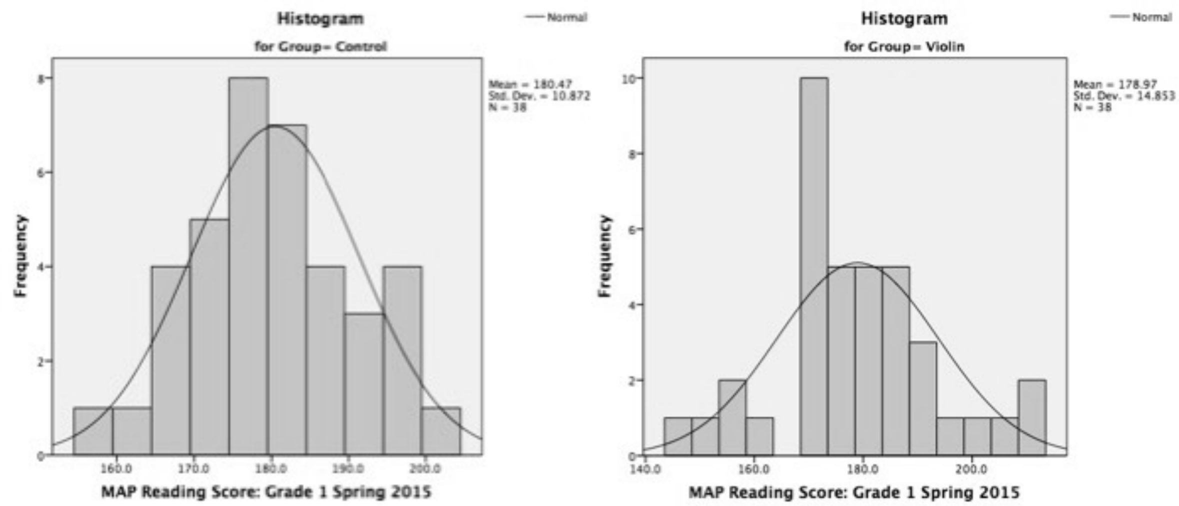

Figure 3. Histograms of MAP reading scores: Grade 1 spring 2015, control and violin groups

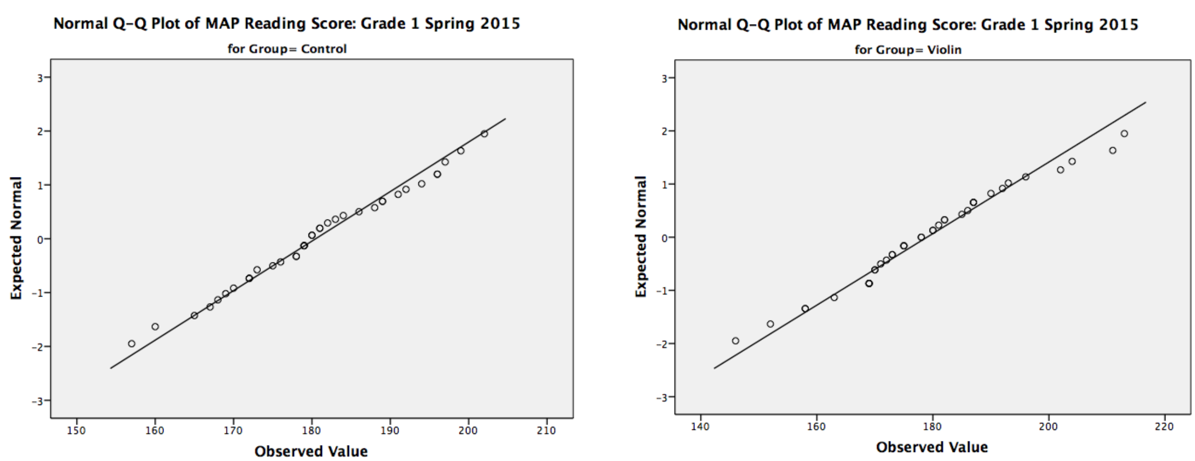

Figure 4. Q-Q Plots of MAP reading scores: Spring 2015, control and violin group

Visual inspection of the scatterplot matrix (see Figure 5) showed a linear relationship between the covariate and the dependent variable (posttest) for each level of the independent variable.

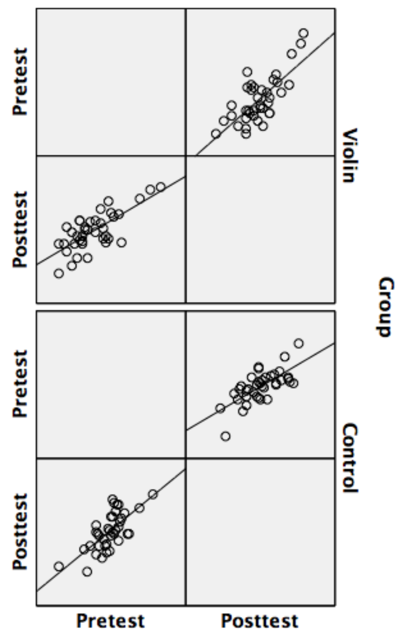

Figure 5. Scatterplot Matrix: Covariate (pretest) and dependent variable (posttest), control and violin group

Homogeneity of Variance

To test for homogeneity of variance, I conducted a Levene's Test of Equality of Error Variances including the pretest as the covariate, posttest as the dependent variable and group as the fixed factor. Results (see Tables 9 and 10) indicate that the assumption of homogeneity of variances was not violated: p = .132 for post-intervention reading scores.

I also used Levene's Test of Equality of Error Variances to check whether the distribution was normal between each subgroup within the control and violin groups: Gender, ethnicity, and at-risk. The results (see Tables 11 and 12) indicate that the assumption of homogeneity of variances was met for all subgroups and the between-subject effects because all p values are greater than .05.

Table 11

Levene's Test of Equality of Error Variances, Dependent Variable: Grade 1 Posttest

F	df1	df2	Sig.
1.335	14	61	.214

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + MAP_Reading2013 + Group + Gender + Ethnicity + AtRisk + Group * Gender + Group * Ethnicity + Group * AtRisk + Gender * Ethnicity + Gender * AtRisk + Ethnicity * AtRisk + Group * Gender * Ethnicity + Group * Gender * AtRisk + Group * Ethnicity * AtRisk + Gender * Ethnicity * AtRisk + Group * Gender * Ethnicity * AtRisk

Table 12

Tests of Between-Subjects Effects, Dependent Variable: Grade 1 Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7208.392[a]	15	480.559	5.369	.000	.573
Intercept	1102.824	1	1102.824	12.320	.001	.170
MAP_Reading2013	4067.807	1	4067.807	45.444	.000	.431
Group	13.817	1	13.817	.154	.696	.003
Gender	12.255	1	12.255	.137	.713	.002
Ethnicity	28.574	1	28.574	.319	.574	.005
AtRisk	155.815	1	155.815	1.741	.192	.028
Group * Gender	5.788	1	5.788	.065	.800	.001
Group * Ethnicity	194.239	1	194.239	2.170	.146	.035
Group * AtRisk	91.224	1	91.224	1.019	.317	.017
Gender * Ethnicity	168.934	1	168.934	1.887	.175	.030
Gender * AtRisk	15.942	1	15.942	.178	.675	.003
Ethnicity * AtRisk	23.847	1	23.847	.266	.608	.004
Group * Gender * Ethnicity	.429	1	.429	.005	.945	.000
Group * Gender * AtRisk	53.624	1	53.624	.599	.442	.010
Group * Ethnicity * AtRisk	7.498	1	7.498	.084	.773	.001
Gender * Ethnicity * AtRisk	27.470	1	27.470	.307	.582	.005
Group * Gender * Ethnicity * AtRisk	.000	0	.	.	.	.000
Error	5370.806	60	89.513			
Total	2467425.000	76				
Corrected Total	12579.197	75				

(*table continued*)

a. R Squared = .573 (Adjusted R Squared = .466)

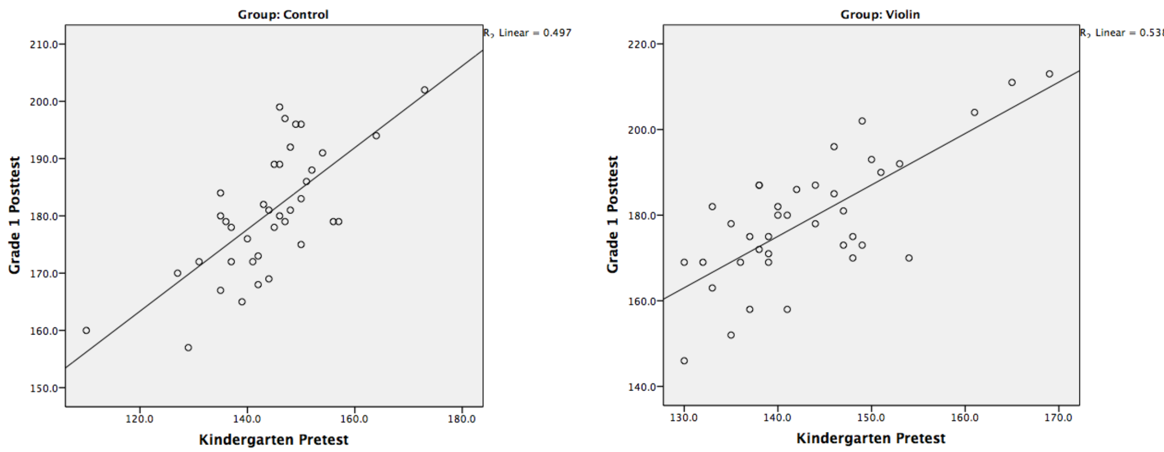

Figure 6. Scatterplot, groups; covariate Fall 2013, dependent variable Spring 2015

Homogeneity of Regression Slopes

To test for homogeneity of regression slopes, I generated scatterplot graphs of the dependent variable and the covariate: One mapping pretest and posttest reading scores for the violin group and the other for the control group (see Figure 6). The regression lines on the two graphs show linear relationships between the experimental factor and covariate, indicating that the assumption of homogeneity of regression slopes has been met.

I also conducted a custom model analysis in ANCOVA by including both the main effects of experimental factor (violin) and covariate (pre-intervention MAP reading scores) and their interaction (see Tables 13 and 14). If the interaction of group and the covariate is significant, then the assumption of homogeneity of regression slopes has been violated. Table 14 shows the results of this test, $p = .646$, so the assumption was not violated.

Table 13

Levene's Test of Equality of Error Variances, Dependent Variable: Grade 1 Posttest

F	df1	df2	Sig.
1.652	14	61	.091

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group + Gender + Ethnicity + AtRisk + MAP_Reading2013 + Group * Gender * Ethnicity * AtRisk * MAP_Reading2013

Table 14

Tests of Between-Subjects Effects, Dependent Variable: Grade 1 Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7494.623[a]	19	394.454	4.344	.000	.596
Intercept	554.890	1	554.890	6.111	.016	.098
Group	209.907	1	209.907	2.312	.134	.040
Gender	29.151	1	29.151	.321	.573	.006
Ethnicity	1.928	1	1.928	.021	.885	.000
AtRisk	17.528	1	17.528	.193	.662	.003
MAP_Reading2013	2614.150	1	2614.150	28.791	.000	.340
Group * Gender * Ethnicity * AtRisk * MAP_Reading2013	1040.569	14	74.326	.819	.646	.170
Error	5084.575	56	90.796			
Total	2467425.000	76				
Corrected Total	12579.197	75				

a. R Squared = .596 (Adjusted R Squared = .459)

Independence

I conducted an ANOVA to test if the number of pre-intervention MAP reading scores (the covariate) was independent of the groups. Results (see Tables 15 and 16) indicate that the covariate is independent or not significantly different $F(1,74) = .097$, $p = .756$ in the pretests of the control and violin groups.

Table 15

Levene's Test of Equality of Error Variances, Dependent Variable: Kindergarten Pretest

F	df1	df2	Sig.
.100	1	74	.752

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Table 16

Tests of Between-Subjects Effects, Dependent Variable: Kindergarten Pretest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9.592[a]	1	9.592	.097	.756	.001
Intercept	1567595.066	1	1567595.066	15859.531	.000	.995
Group	9.592	1	9.592	.097	.756	.001
Error	7314.342	74	98.842			
Total	1574919.000	76				
Corrected Total	7323.934	75				

a. R Squared = .001 (Adjusted R Squared = -.012)

Presentation of Results of ANCOVA

With all assumptions of ANCOVA met, I conducted the main analysis (see Tables 17 and 18) selecting the kindergarten MAP reading scores fall 2013 as the covariate, first grade MAP reading scores spring 2015 as the dependent variable and the following as fixed factors: Group, gender, ethnicity, and at-risk. I ran a full-factorial analysis and selected the bootstrap option to ensure that the results derived from robust estimates of standard errors and confidence intervals. The results (see Tables 17 and 18) indicate that the covariate, kindergarten MAP reading pretest scores, was significantly related to the first grade MAP reading posttest scores, $F(1,60) = 45.44$, $p < .004$, $\eta^2 = .43$.

There was no significant effect of the violin intervention on first grade posttest MAP reading scores after controlling for the effect of the pretest, $F(1,60) = .154$, $p = .696$, $\eta^2 = .003$. In addition, there was no significant main effect of gender, ethnicity, and at-risk on first grade posttest MAP reading scores, as well as no significant effect of their interactions. Therefore, the study failed to reject the null hypothesis that there is no significance between the MAP reading scores of students receiving 2 consecutive years of string instruction and students receiving no string instruction. A bootstrap *post hoc* test (see Table 20) was used to correct bias using a confidence interval level of 95%. In Table 19, the control group had slightly higher first grade posttest scores, *M* = 179.30 [176.64, 182.41] than the students receiving violin instruction, *M* = 177.99 [174.10, 182.75], yet the mean difference between the groups in a bootstrap pairwise comparison (see Table 20) was not significant (p = .547). The fact that the confidence interval crosses zero, MD = 1.32 [-3.446, 5.50] confirmed that there is no statistically significant difference between the groups.

Table 17

Levene's Test of Equality of Error Variances, Dependent Variable: Grade 1 Posttest

F	df1	df2	Sig.
1.335	14	61	.214

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + MAP_Reading2013 + Group + Gender + Ethnicity + AtRisk + Group * Gender + Group * Ethnicity + Group * AtRisk + Gender * Ethnicity + Gender * AtRisk + Ethnicity * AtRisk + Group * Gender * Ethnicity + Group * Gender * AtRisk + Group * Ethnicity * AtRisk + Gender * Ethnicity * AtRisk + Group * Gender * Ethnicity * AtRisk

Table 18

Tests of Between-subjects Effects, Dependent Variable: Grade 1 Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7208.392[a]	15	480.559	5.369	.000	.573
Intercept	1102.824	1	1102.824	12.320	.001	.170
MAP_Reading2013	4067.807	1	4067.807	45.444	.000	.431
Group	13.817	1	13.817	.154	.696	.003
Gender	12.255	1	12.255	.137	.713	.002
Ethnicity	28.574	1	28.574	.319	.574	.005
AtRisk	155.815	1	155.815	1.741	.192	.028
Group * Gender	5.788	1	5.788	.065	.800	.001
Group * Ethnicity	194.239	1	194.239	2.170	.146	.035
Group * AtRisk	91.224	1	91.224	1.019	.317	.017
Gender * Ethnicity	168.934	1	168.934	1.887	.175	.030
Gender * AtRisk	15.942	1	15.942	.178	.675	.003
Ethnicity * AtRisk	23.847	1	23.847	.266	.608	.004
Group * Gender * Ethnicity	.429	1	.429	.005	.945	.000
Group * Gender * AtRisk	53.624	1	53.624	.599	.442	.010
Group * Ethnicity * AtRisk	7.498	1	7.498	.084	.773	.001
Gender * Ethnicity * AtRisk	27.470	1	27.470	.307	.582	.005
Group * student_gender * Group_Ethnicity * AtRisk	.000	0	.	.	.	.000
Error	5370.806	60	89.513			
Total	2467425.000	76				
Corrected Total	12579.197	75				

a. R Squared = .573 (Adjusted R Squared = .466)

Table 19

Estimated Marginal Means for Group, Dependent Variable: Grade 1 Posttest

Group	Mean	Std. Error	95% Confidence Interval		Bootstrap for Mean[aaa]			
			Lower Bound	Upper Bound	Bias	Std. Error	95% Confidence Interval	
							Lower	Upper
Control	179.304[a,b]	1.886	175.531	183.076	.077	1.460	176.635	182.405
Violin	177.980[a]	1.860	174.259	181.701	.327	2.275	174.099	182.754

a. Covariates appearing in the model are evaluated at the following values: Kindergarten Pretest = 143.618.

b. Based on modified population marginal mean.

aaa. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 20

Bootstrap for Pairwise Comparisons for Group, Dependent Variable: Grade 1 Posttest

(I) Group	(J) Group	Mean Difference (I-J)	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
Control	Violin	1.323	-.250	2.260	.547	-3.446	5.549
Violin	Control	-1.323	.250	2.260	.547	-5.549	3.446

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Summary

The research question of this study is: What is the relationship between instrumental music and academic achievement on MAP reading scores of first graders who received at least 90 minutes per week of string instruction for 2 consecutive years at a Title I school? The results of the ANCOVA indicated that there was no significant effect on MAP reading scores of first graders who had consistently received 90 minutes per week of violin instruction during their public school curriculum in kindergarten and first grade. Subsequently, the null hypothesis was retained. The results and the interpretation of the findings will be discussed further in Chapter 5, along with implications for social change and recommendations for future research.

Chapter 5: Discussion, Conclusions, and Recommendations

This quasi-experimental study tested Vygotsky's sociocultural theory that playing a musical instrument is significantly associated with academic achievement in reading for first graders who attended one of two schools in Alaska. The independent variable was first graders who consistently participated in an in-school violin program for 2 years, the dependent variable was first grade MAP spring 2015 reading scores (posttest), and the covariate was kindergarten MAP fall 2013 reading scores (pretest). The purpose of this study was to determine whether instrumental music as an early childhood intervention could contribute to academic achievement in reading for students from lower socioeconomic backgrounds who may not otherwise afford it. Results of this study determined that there was no significant effect of the violin program on first grade posttest MAP reading scores after controlling for the effect of the pretest. Therefore, the study failed to reject the null hypothesis that there is no significance between the MAP reading scores of students receiving 2 consecutive years of string instruction and students receiving no string instruction.

Interpretation of the Findings

The ANCOVA analysis found no significant effect of the violin intervention on Grade 1 posttest MAP reading scores after controlling for the effect of the pretest, $F(1,60) = .154$, $p = .696$, $\eta^2 = .003$. When comparing these results with those presented in the peer-reviewed literature, the findings both support and counter knowledge regarding the discipline of music education, cognition, and reading achievement. The combination of unique factors of this study, which include longitudinal, Sistema-inspired program, as well as MAP reading scores of participants aged 6-7, attributed to the mixed results.

When examining longitudinal studies, much of the current research involving slightly older children (Chobert et al., 2014; Francois et al., 2013; Holochwost et al., 2017; Moreno et al., 2009) refutes the findings of this study. Chobert et al. (2014) and Francois et al. (2013) conducted randomized studies involving 24 children aged 8-10. Although the children in these studies were older than those in this study, they shared similar economic status (middle to low) and the intensity and duration of the music trainings were similar: Training lasted from October to May, twice a week for 45 minutes each during the first year and one session of the same length for the second year. After one year, both studies found that children who received music training were more sensitive to acoustic and phonological cues than the control group who received painting lessons (Chobert et al., 2014) and had improved speech segmentation abilities the second year (Francois et al., 2013).

Moreno et al. (2009) also studied older children (aged 8) with no previous music training. Of the 57 participants, half received Kodaly and Orff-Schulwerk general music instruction, while the other half received painting lessons for 24 weeks, 2 times/week for 75 minutes each. The shorter timeframe of 24 weeks still produced positive reading results that this study could not validate. Moreno et al. (2009) found that only the musical training group had improved reading skills and enhanced pitch discrimination in terms of speech. Holochwost et al. (2017) involved 265 randomly selected children (grades 1–8) who participated in an after-school Sistema-inspired program for either one, two, or three years. Unlike this study, the program did not occur during school hours, excluded kindergartners, and provided music every day for 2 hours/week for 39 weeks, rather than 90 minutes/week. However, it did use MAP scores in language as one of its test measures. Holochwost et al. (2017) found that students enrolled in the music program exhibited higher scores in language and math in MAP standardized tests with the greatest difference occurring between the control group (no music training) and students who had participated in the program for 2 or 3 years.

Slater et al. (2014) yielded similar results as those of this study, but within a one-year time frame rather than two. Forty-two Spanish-English bilingual children (aged 6-9) were pseudo-randomly assigned to either a music or control group after an initial assessment that matched groups according to age, gender, IQ, age of English acquisition, reading ability and level of maternal education. Slater et al. (2014) determined that the reading scores of students in the music training group did not improve, but rather maintained their age-normed level, whereas the control group showed a decline in reading scores. Because the participants came from low-income and bilingual families, Slater et al. (2014) interpreted the results as evidence that music participation may counteract the negative impact that low SES status may have on maintaining literacy levels.

Vygotsky's sociocultural cognitive theory recognizes the interconnectedness of human development and the sociocultural context in which an individual lives. The brain can change through a child's interaction with the environment, which in this study is music instruction. The difference in growth between the pretest and posttest scores of the two groups, although not significant, offers potential research for the future: The median and mode of the control group was 35.5 and 33, respectively, while the violin group had means of 38.5 and 39. Although the sample size of this study was too small to isolate students eligible for FRL, the control group only had 18% of students eligible for FRL, while the violin group had 32%. A larger sample size may have helped avoid these unequal distributions.

This study refuted the results of studies involving participants with similar age ranges and phonological awareness as the research topic (Degé et al., 2015; Patscheke et al., 2016). Moritz et al. (2013) conducted a correlational study involving 30 kindergartners aged 5 that examined the link between their rhythm skills and phonological awareness. The study involved two groups: An experimental group who received 45-minute Kodaly-based music lessons, 5 times per week and a control group who received one 35-minute general music class per week. Moritz et al. (2013) found that a kindergartner's rhythm ability significantly correlated with phonological awareness skills and basic word identification in Grade 2. Degé et al. (2015) examined both music perception and music production as they relate to phonological awareness and other precursors of reading with 55 preschoolers aged 6 and found that musical abilities were more closely associated with phonological awareness at the word level (rhymes and word segmentation) than the phoneme level (phoneme recognition). Patscheke et al. (2016) also determined that both music and phonological skills groups showed a significant increase ($p < .001$) in phonological awareness at the word level (blending, segmentation, and rhyming) after receiving training 3 times a week for 20 minutes each for 14 weeks.

Their study randomly assigned 39 preschoolers aged 4-7 from immigrant families to one of three groups: Music, phonological skills training, or sports. All three studies found a correlation between music training and increased phonological awareness at the word level, not the phoneme level. Concerning my own study, it would be interesting to examine whether the violin participants also scored higher than the control group on MAP test questions assessing phonological awareness at the word level. According to the NWEA (2017), the kindergarten and first grade MAP reading test assesses ten skill sets of which half involve identifying and decoding words.

Lastly, the findings of this study corroborate with studies that showed no significant difference between participants receiving music training and those who received an alternative or no additional training. Kempert et al. (2016) conducted a longitudinal study involving 424 German-speaking children aged 4-5 recruited from 34 preschools. The quasi-experimental study examined whether music training combined with a well-established phonological awareness training would have a stronger impact on phonological awareness skills than the phonological awareness training alone. Kempert et al. (2016) found that the addition of either training (music or phonological awareness) did not significantly contribute to phonological awareness (broad or narrow) for children with normally- or weak-developed skills. Forgeard et al. (2008) also did not find a correlation between musical training and spatial reasoning, mathematical skills, and phonemic awareness for 59 children (aged 10) who had three years of instrumental training.

The results from this study also contributed to the on-going question of whether children with a high IQ are inclined to take music lessons (Corrigall & Schellenberg, 2015; Schellenberg, 2011). Habibi et al. (2014) provided baseline data that indicated no pre-existing differences in children before musical training in cognitive, motor, musical, emotional, or social behaviors, as well as structural and functional brain measures. This study extends the work of Habibi et al. (2014) by contributing baseline data of Title I students in Alaska who participate in during school programming where it is required. With Sistema programs continuing to grow nationwide (El Sistema USA, 2017b), future studies involving in-school programs like this study, where instrumental training is required and part of the school curriculum, will help answer the nature versus nurture question.

Limitations of the Study

A small sample size limited the generalizability of this study. With 57 students in the population of the control group and 85 in the violin group, I crafted this study with a larger sample size in mind. Unfortunately, the transiency rate of the population of these two schools (or incompletion of both pre- and posttest) was higher than expected: 22% transiency rate for the control group and 50% for the violin group. By reducing the intended sample size from 50 to 38, I lost the opportunity to match as closely as possible the income level and demographics of both groups. In particular, the control group, which should have reflected the school population demographics of 37% students eligible for FRL, only had 18%. Similarly, the violin group, which should have had 5% of its participants ELL, had none represented in the sample.

Both groups had few special needs students (IEP), which should have reflected the school population of 20% and 15% of the control and violin group, respectively. And lastly, the violin group had 50% more students who identified themselves as Alaska Native than the control group. In an effort to include and represent these factors as part of the analysis, despite the small numbers, I collapsed all four categories (AK, ELL, IEP, FRL) into one category termed At-Risk, which may not have adequately represented the impact of each at-risk factor on reading achievement. Unfortunately, the smaller sample size of this study made it infeasible.

Concerning limitations to this study's internal validity, the research design was a quasi-experimental study using a convenience sample and therefore a threat to internal validity from the outset because the groups did not constitute a random sample. To help rectify this issue, I used a MAP reading assessment, which is a standardized measuring tool evaluated for validity and reliability by an outside source. These scores were administered by classroom teachers and evaluated by NWEA, so as the researcher, I had no involvement in the data collection process. Although participants were in different classrooms, which could pose a threat to the intrinsic factor of history, both sites used the same reading and math programs and shared fairly similar demographics and socio-economic status when variables were collapsed into broader categories (White and Other and At-Risk).

The results of the ANCOVA included factors of gender, ethnicity, and at-risk, which showed no significant impact on first grade MAP reading scores. Also, this study involved all students in first grade who consistently attended one of two Title I schools in the Alaskan School District for 2 years. Rather than conduct a study where students and families self-selected to participate in the violin program, this Sistema-inspired program removed this limiting factor by holding group violin lessons during school hours and as a required component of the curriculum.

Although both schools have a transient population, children who moved in and out of either school site during kindergarten or first grade were eliminated from the study to avoid experimental mortality. I only included in the study scores of students who had been in the violin program for 2 years (treatment group) and students who had attended both kindergarten and first grade (without interruption) at the control site. Controlling characteristics for the two groups helped contribute to intrinsic factors of validity and focused the study on the effectiveness of the intervention. Using secondary data also removed the researcher from the initial data collection process. As a music teacher, creator of the violin program, and researcher of this study, using secondary data ensured that my biases did not compromise the validity of the data collection or analysis.

Recommendations

The strengths of this study stem from the ability to conduct research at a Title I school where all kindergarten and first graders receive 90 minutes/week of violin instruction. The uniqueness of this program became apparent when completing the literature review for this study. Most studies that focused on young children and instrumental music identified participants through recruitment fliers, lottery system, or those who already played an instrument--all of which tapped into a population who already had an interest in music. Sistema-inspired programs like the one in Alaska level the playing field by focusing on Title I schools and requiring all students at an early age to participate in instrumental training, tuition-free. In doing so, the context of this study removed the argument that "pre-existing individual differences determine who takes music lessons" (Corrigall & Schellenberg, 2015, p. 1).

The weaknesses of this study are that the sample size was too small to authentically measure the heterogeneity that exists in Title I schools, including ethnicity, FRL, ELL, and students receiving special services. Compound this with very young participants who enter school with a wide range of school readiness skills, and the need for future longitudinal studies spanning several years and involving greater numbers of students becomes apparent. The violin program in Alaska currently has programming in three schools (two of which are Title I). I would recommend that a larger-scale study involving these sites be conducted in cooperation with the school district to more effectively measure the impact of instrumental training for primary school children. Although the violin program in this study moves to an after-school program in second grade, there are other Sistema-inspired programs throughout the United States that deliver their programming during school hours for older grades.

Since NWEA provides MAP testing for over half the schools in the United States (NWEA, 2017a), I recommend that similar research be conducted by intensive in-school music programs that are required by all students. The collective efforts of a network of programs like El Sistema USA could help address the challenges that this study faced. Also, as the director of the violin program and school music teacher at the violin group school site, I could not conduct qualitative research because of the inherent biases that come from working so closely with the participants. I would recommend that future research on the topic of music training and reading achievement for elementary children incorporate a mixed methods approach where the voices of classroom teachers, parents, and students can speak to the impact that music training has on the academic lives of children, not only through student test scores, but also noncognitive factors that impact learning.

Implications

Although the results of this study did not show a relationship between instrumental music and academic achievement on MAP reading scores of first graders, the study has value because of its potential impact for social change at the local and societal level. As mentioned earlier, this study has unique factors that attributed to both mixed results of affirming and refuting current research in the discipline of instrumental music in Title I schools, reading achievement, and cognition. El Sistema, a social service program from Venezuela that uses music for social change, is a fairly new phenomenon, which took root in the United States in 2008. Nine of the ten studies involving Sistema programs (Habibi et al., 2014; Krauss et al., 2014abc, Kraus et al., 2015; Slater et al., 2013, 2014, 2015) were all conducted at two programs in Los Angeles. Although this is limiting in scope, these are the first published research studies examining the impact that a tuition-free, intensive instrumental music program can have on the development of underserved youth. This study conducted in Alaska contributes to this new field of music for social change and underscores the need for more research at the local and national level on the benefits of music education as a public opportunity, available to all regardless of financial means. In doing so, music education may take a more prominent and required place in the curriculum of elementary schools so that all students have access to the potential benefits that music provides lifelong.

Conclusion

According to Fullan (2007), change is not an event, but rather a process that takes time. The results of this study contribute to an ongoing dialogue about the impact that instrumental music has on the intellectual development of children. When comparing these results with those presented in the peer-reviewed literature, the findings both support and counter knowledge in the discipline of music education and reading skills. The small sample size and other limitations of the study may have contributed to this result, yet the strengths of the study contribute a unique context to the field of research: Alaskan Title I school where all kindergartners and first grade students receive 90 minutes/week of violin instruction as a school readiness and Sistema-inspired program.

Although this study focused on standardized test scores, the overwhelming literature documenting the impact that music training has on brain plasticity and cognition, especially when introduced at an early age, should not be ignored. Longitudinal studies spanning several years of a child's education may better capture the longterm benefits that music education can provide. Future research also should consider expanding measures of academic success to include noncognitive factors such as social-emotional learning and creativity.

An IBM poll of 1,500 CEOs identified creativity as the number one leadership competency of the future (Bronson & Merryman, 2010) where individuals need to be innovative, adaptable, collaborative, and able to think outside the box to solve today's complex challenges. According to Hatch et al. (2013), a five-year longitudinal study of Michigan State University Honors College graduates who majored in science, technology, engineering, and math (STEM) determined that those who owned businesses or patents had 8 times more exposure to the arts as children than the general public. Ninety-three percent of them had musical training.

Wagner (Laureate Education, Inc., 2011) also contended that educational policy in the United States is misguided in its efforts to best prepare its students for a global workforce. Rather than focus on closing the achievement gap, Wagner (Laureate Education, Inc., 2011) urged American schools to focus their efforts on narrowing the global gap and described seven core competency skills that are necessary to survive in the 21st century: Critical thinking, accessing and analyzing information, oral and written communication, collaboration, agility and adaptability, initiative and entrepreneurialism, and curiosity and imagination. Unfortunately, educational policy makers still place a higher priority on standardized tests that limit what can be assessed, including soft skills and dispositions.

Future research also should consider the changing definition of what it means to be literate in the 21st century. The New London Group developed multiliteracies theory (as cited in Mills, 2009) in response to the changing and broadening of various literacies in multimedia and the Internet. Literacy is no longer limited to the written word, but rather is one that combines words, images, and sound to effectively communicate a message for a global audience. Music and the arts are a way to help accomplish all of these skills.

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Appendix A: Letter of Cooperation

Letter of Cooperation from th[redacted]

[redacted]

November 13, 2017

Dear Dr. Heagy,

Based on my review of your research proposal, I give permission for you to conduct the study entitled Instrumental Music and Reading Achievement of Students in Grade 1 within the [redacted] School District. As part of this study, I authorize you to receive de-identified data files from Power School related to demographic information and Measurement of Academic Progress (MAP) scores in Reading for students who attended kindergarten and Grade 1 without interruption at [redacted] Elementary Schools during the 2013-2014 and 2014-2015 school years. [redacted] Assessments and Program Evaluation Director, will provide these data files and assist in any questions you may have concerning the data.

We understand that our organization's responsibilities include: Providing de-identified data of demographic and Measurement of Academic Progress (MAP) scores in Reading of students described above, as well as supervision from [redacted] related to any questions concerning the data, its analysis, and results dissemination. We reserve the right to withdraw from the study at any time if our circumstances change.

I understand that the student will not be naming our organization in the doctoral project report that is published in Proquest.

I confirm that I am authorized to approve research in this setting and that this plan complies with the organization's policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Walden University IRB.

Sincerely,

[redacted]

Appendix B: Data Use Agreement

DATA USE AGREEMENT

This Data Use Agreement ("Agreement"), effective as of December 1, 2017 is entered into by and between Loralie L. Heagy (Data Recipient") and [redacted]ool District ("Data Provider"). The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS") for use in research in accord with the HIPAA and FERPA Regulations.

1. Definitions. Unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the "HIPAA Regulations" codified at Title 45 parts 160 through 164 of the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable HIPAA or FERPA Regulations

Data Fields in the LDS. **No direct identifiers such as names may be included in the Limited Data Set (LDS).** The researcher will also not name the organization in the doctoral project report that is published in Proquest. In preparing the LDS, Data Provider or designee shall include the **data fields specified as follows**, which are the minimum necessary to accomplish the research:

- Unique Identifier
- School Attended Consecutively for two years without Interruption for Kindergarten (2013-2014) and Grade 1 (2014-2015) a[redacted] and [redacted]Elementary Schools
- Grade
- Gender
- Ethnicity
- Days of Membership: 2013-2014 (Kindergarten) and 2014-2015 (Grade 1)
- Days of Absence: 2013-2014 (Kindergarten) and 2014-2015 (Grade 1)
- Measurement of Academic Progress (MAP) Scores in Reading (RIT and NPR Scores):
  - Kindergarten Fall 2013
  - Grade 1 Spring 2015
- Demographic Flags:

3. Responsibilities of Data Recipient. Data Recipient agrees to:

a. Use or disclose the LDS only as permitted by this Agreement or as required by law;

b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

e. Not use the information in the LDS to identify or contact the individuals who are data subjects.

4. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS for its research activities only.

5. Term and Termination.

a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

6. Miscellaneous.

a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER	DATA RECIPIENT
Signed: [redacted]	Signed: Loralie L Heagy
Print Name: 11/17/17	Print Name: Loralie L. Heagy
Print Title: Superintendent	Print Title: PhD Candidate