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Effectiveness of grouping middle school students based on learning modality preferences on vibrato acquisition

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EFFECTIVENESS OF GROUPING MIDDLE SCHOOL STUDENTS
BASED ON LEARNING MODALITY PREFERENCES
ON VIBRATO ACQUISITION

by

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Dedication

This work is dedicated to two very important people without whom this work would have existed only in my imagination. Dr. Lili M. Levinowitz, my master’s thesis advisor at Rowan University inspired me to continue my work with learning styles and music, believing that I had something meaningful to offer music education research. My wife Michelle who stood by me from my first course in the doctorate program, to the completion of this dissertation and while never fully understanding my need to reach beyond, made it important to her because it was important to me.
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ABSTRACT

The purpose of this study was to examine the effectiveness of grouping middle
school students by learning modality preferences on vibrato acquisition. Traditional
approaches to teaching vibrato synthesize reading and listening to elicit an appropriate
tactile response, however, Ornstein (1995) identified this approach as a narrow scope
suited to a “hypothetical average student” (p.105). Keefe (1985) proposed learning styles
as a reliable lens for understanding the individuality of learning.

Music education research has a pronounced lack of pedagogical studies
addressing technical development particularly regarding stringed instruments. A majority
of vibrato research in particular has been regulated to diagnostic studies of the behavior
of its inherent acoustic properties. Of the several tutorial vibrato studies that exist,
namely those by Gillespie (1997), and Shepherd (2004), few examined beyond two of the
primary sensory (e.g., visual and auditory) learning modes identified by Swassing and
Barbe (1979). This study challenged traditional approaches by accommodating
individual sensory preferences as the most promising path to learning vibrato.

Dominant learning preferences of 60 middle school orchestra students were
identified using VARK (Fleming, 2001), an instrument whose name is derived from an acronym for Visual, Auditory, Read/Write, and Kinesthetic. Based on VARK (Fleming, 2001), results, four groups were created corresponding to three learning preferences and a control group. Pretest recordings were made to evaluate existent vibrato abilities and all subjects participated in six weeks of intervention vibrato lessons where teaching was deliberately matched to each group’s learning preference. The control group was taught using a traditional class method book. Following the intervention period, posttest recordings were made as an exit assessment. All recordings were evaluated by a panel of qualified string educators using Gillespie’s (1993) vibrato evaluation instrument and three data sets were constructed corresponding to means of the pretest, posttest, and a means of difference between the two. Analysis included measures of central tendency, Kruskal-Wallis $H$ test and frequency distributions. Descriptive statistics were computed for grade, gender, and instrument to examine latent peripheral relationships and no significant differences were found between learning preference groups and the control group compelling the researcher to accept the null hypothesis.
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Chapter I

Introduction

A successful lesson is based, in part, on the transfer of knowledge and/or skills so that they can be recalled, or reproduced consistently, accurately, and independently. No single teaching approach however appears to be sufficient for reaching the multiplicity of learners that exist in a classroom. Schools though tend to favor uniformity over diversity and thus often rely on autocratic teaching methods like direct instruction (Guild, 2001). Rischin (2002) believed that, “teachers should try to mold their methods to fit their students instead of trying to mold their students to fit their methods” (p.53). Learning modality has been proposed as an approach that merits attention by teachers for connecting with the individuality of learners (Campbell, 2008).

Learning styles research has been of interest to educators for at least the past four decades (Cassidy, 2004). Differentiated instruction represents the most current pedagogical movement to respect individuality among learners. Matching instruction with a student’s preferred learning modality is a core differentiated feature according to Tomlinson (2000), and Barbe and Swassing (1979) cited perceptual sensory modalities as having the greatest utility in promoting student success. Reynolds and Gerstein (1991) recognized a propensity for the visual (seeing) sensory mode over the auditory (hearing) sensory mode as an example of demonstrating a learning style preference. Learning preferences may or may not coincide with the greatest strength but may still represent the learner’s inclination to enact his/her most successful approach.

Sensory modalities have also been recognized as a suitable approach for
addressing music instruction, according to Lemire (1996). Although string instrument performance inherently engages multiple senses (e.g., visual auditory and kinesthetic), pedagogy has remained largely uni-sensory favoring the oral tradition as the predominant instructional method (Zhukov, 2007). Possible reluctance among string teachers to move beyond the safety of routine, may have led Nelson (1983) to suggest that “string teaching is traditionally resistant to change” (p. 43).

String class pedagogy is often based on studio teaching rendering some approaches impractical for use in group instruction (Nelson, 1983). Because vibrato is believed to be better suited to a private studio than a classroom, some classroom string teachers consider the teaching of vibrato expendable (Ely, 1993). Vibrato has been identified as one of the most frequently discussed topics in clinics and workshops, yet the least consistently adopted into string programs in addition to being among the most difficult of skills to teach on a string instrument (Stewart, 1933, Kotchenruther, 1998, Wisniewski & Mueller, 1998, Shepherd, 2004, MacLeod, 2008).

Since string vibrato is initiated physically, the tactile component is overtly visual. Early research conducted by Seashore (1931) at the University of Iowa identified the properties of a vibrato oscillation as demonstrating rate, width and shape, all aligning with the fundamental sensory modes as recognized by Barbe, Swassing, and Milone (1979). Engaging movement at macro and micro levels involving the arm, wrist and finger synthesizes the kinesthetic and auditory elements of vibrato that are characteristic features associated with successful teaching and acquisition of the skill. Moreover, oscillation rate, width and shape directly result from the manner in which a student
manages the dexterity of these motions. Consequently, adjustments are made in response to auditory feedback, either to increase or decrease the speed, or width to accommodate appropriate vibrato.

Just as vibrato engages artistry that characterizes the expressive originality of a performer (Lee, 1999), student learning styles exemplify a personal dimension of a student’s intellect. Despite that vibrato instruction resonates with learning styles philosophy, studies investigating the effectiveness of teaching vibrato via a learning styles approach have been virtually non-existent. The crux of learning styles research belongs to the core academic subjects while learning styles studies in music education remain relatively unexplored. Molumby (2004), for example, examined how university flute students responded to lessons that accommodated personal learning preferences. Data collected from exit interviews indicated that students identified positively with lessons that corresponded to individual learning preferences although no specific instrumental technique was targeted as a goal.

Some other studies focused explicitly on investigating alternative means of teaching vibrato, examining audio versus audio/visual presentations (Gillespie, 1997), and employing video instruction (Shepherd, 2004). Emphasizing presentation mode without considering student learning preference, however, perpetuates the teacher dominant model that is contrary to learning styles education. Bell (2007), for instance, believed that the lack of empirical vibrato studies has created a deficit of resources to assist teachers with making informed decisions regarding their instructional approaches. Moreover, potential benefits of learning styles approaches have been found to be, at best,
indecisive and inconclusive (Eastman 2004; Williams, 2010). Vibrato is the least standardized of teachable strings techniques and therefore warrants exploring the most efficient means of supporting the success of strings students.

**Purpose**

The purpose of this study was to examine the effects of matching teaching styles (e.g., visual, auditory, or kinesthetic) with dominant student learning modalities on the learning of vibrato among middle school strings students. A null hypothesis was put forth that no significant differences will occur between student groups who are taught traditionally and those whose learning preferences are matched with an accommodating teaching style.

This study addressed the following research questions:

1. To what extent does matching teaching to individual learning preferences effect progress with learning vibrato on a string instrument among middle school students?

2. What differences exist, if any, with vibrato acquisition on string instruments among students in grades six, seven, and eight when teaching is matched to individual learning preferences?

3. What differences exist, if any, with vibrato acquisition on string instruments between boys and girls when teaching is matched to individual learning preferences?
4. What differences exist, if any, with vibrato acquisition on string instruments among instruments (e.g., violin, viola, cello, and double bass) when teaching is matched to individual learning preferences?

**Rationale**

Traditional teaching according to Nehring (2004) “is largely the result of outdated policy changes that have calcified into conventions” (p. 1). The autocracy of traditional teaching models encourages a teacher dominate classroom in which the teacher’s instructional method most likely aligns with his or her own learning style rather than that of his/her students. Ornstein (1995) recognized a major limitation of traditional teaching as being, “geared to a hypothetical average student, which only fits a few students in the class, and all students are expected to learn and perform within narrow limits” (p. 105). Dunn and Dunn (1993) cited the plurality of distinct biological and environmental characteristics as reasons why a singular teaching approach is ineffective for reaching all learners in a classroom. Fleming and Baume (2006) identified learning diversity as being as much a part of one’s intellectual identity as are preferences for colors or foods. Learning preferences are believed to have pragmatic face validity because, they encourage more favorable responses from students and engage more “meaningful learning” (Briggs, 2003, p. 19), than traditional methods (Given, 1996, Beck, 2001). According to Dunn (2009), instruction that complements a student’s learning style is a more effective means of delivering information because stimulating a student’s cognitive strength minimizes miscommunication and therefore, bolsters comprehension. Bonwell
(1991) suggests that in a traditional teacher centered environment, the amount of information retained by students declines substantially after ten minutes. Therefore, actively engaging the student as the main agent of learning creates a more genuine educational experience with authentic personal value that could benefit retention rate and long term achievement.

Vibrato instruction has historically been the least standardized of string techniques because apparently, there are as many opinions on teaching vibrato as there are ways to do it (Clark, 1989, Gholson, 1998, Geringer, Allen, & MacLeod, 2005). Private music lessons hold optimum value for introducing technical skills on a string instrument largely because of the level of personalized mentorship that is inherent in a setting where the teacher-pupil ratio is one to one, however, studio pedagogy though is seldom suitable for a class environment. Consequently, some string teachers rely on method books as a source for introducing and refining technical skills like vibrato in a class. Method books are often intentionally designed to unify concepts and streamline instruction in large heterogeneous group environments although printed material has been recognized as favoring only 30% of students who are visual learners (Kerner, 1969, Kempter, 1979, Byo, 1988). Consequently, vibrato development is usually marginalized by a lack of understanding among students who do not demonstrate text based or visual strength.

Dickey (1991) suggested sensory learning models as a compatible option for advancing virtually any technique that is encountered in an instrumental ensemble. Opposing views, however, failed to find merit in emphasizing learning styles based instructional approaches. Brown (2003) for example claimed that aligning teaching with
student learning style will not necessarily guarantee achievement. Stahl (1999) recognized that every teachable task has a unique inherent means that is conducive for teaching it most effectively with which Glenn (2009) agreed. “Nearly everyone would prefer a demonstration in a science class to an uninterrupted lecture. This does not mean that such individuals have a visual style, just that good science teaching involves demonstrations” (Stahl, 1999, p. 3).

Data supporting or refuting the value of a learning styles approach to teaching have been inconclusive at best both in academics as well as music. Although Mason (1990), for instance, failed to find a correlation between sensory mode and music reading skill among seventh grade instrumentalists, Korenman and Peynircioglu (2007) concluded that teaching to a student’s sensory preference plays an active role in learning melodic patterns. Furthermore, accuracy with recalling patterns seemed to correlate when presentation modes matched individual learning preferences. Since characteristics of vibrato are initiated and controlled by patterned motions that are blended and balanced in order to achieve artistic expression, sensory preference may hold an advantage for teaching pattern recall necessary for vibrato production as well. This study is predicated upon recognizing that teaching to individual learning preferences is believed to not only facilitate learning, but also stimulate the mind and body to negotiate conceptual knowledge and enact inductive reasoning that will assist students in mediating differences within mixed instrumentation with greater intellectual authority (Ford & Chen, 2001, Dunn, 2009).
Methodology

This study followed a quasi-experimental design due to the lack of random assignment of participants to one of the three experimental or control groups. Furthermore, since the purpose of this study was to project generalizable results regarding vibrato teaching methods, a quantitative model was chosen as most suitable.

Students in grades 6, 7, and 8 who attend a northern New England middle school (N = 60) participated in this study of learning modalities and vibrato for a period of eight weeks. The study comprised three phases; pretest, intervention, and posttest. The initial phase engaged subjects in a vibrato pretest to assess existing skill level and establish a baseline for the study. Next, the dominant learning preferences of all subjects was identified using VARK (Fleming, 2001), a learning preference profile whose name is derived from the four preferences that it identifies as Visual, Auditory, Read/Write, and Kinesthetic. Based on data collected from VARK (Fleming, 2001), three experimental groups were formed corresponding to visual, auditory or kinesthetic. A control group was also formed from those participants who demonstrated a strong read/write preference.

Phase two of the study involved an intervention period during which each group received a course of 12, 30 minute group vibrato lessons over the duration of six weeks. Instruction during the lessons was tailored to accommodate matching the learning modality preferences of each experimental group. The visual group for example, watched The Art of Vibrato DVD (Fischbach, 2004), absent of the audio track. The Art of Vibrato (Fischbach, 2004) is a companion videodisc to Viva Vibrato (Fischbach, 1998) that presents all of the same material in the same sequence as the printed text. The auditory
group listened to the audio track only of the same video absent of the images and the kinesthetic group performed exercises emulating the mechanics of vibrato production.

The control group was taught using the print version of *Viva Vibrato* (Fischbach, 1998), a vibrato exclusive method book designed for use in a heterogeneous classroom to simulate a traditional whole class approach. Data were collected from the pretest and posttest using a Zoom H2 handheld digital recorder whereupon audio files were transferred to and archived on compact disc via laptop computer. Recordings were then evaluated by a panel of string specialists employing Gillespie’s (1993) vibrato evaluation form to assess vibrato development. Measures of central tendency were computed for data collected from the pretest and posttest evaluations and the null hypothesis was tested using a Kruskal-Wallis $H$ test.

**Delimitations**

The scope of this study examined the effectiveness of matching instruction with individual student learning modality preferences upon developing vibrato skills on string instruments. Therefore, it was critical to the integrity of the study that the subjects had limited or no previous experience with vibrato and thus the study was delimited to string orchestra students in grades 6, 7, and 8 who attend a middle school in Concord, New Hampshire and for whom vibrato was a new skill. Students who met all of the demographic criteria but were determined from the pretest to demonstrate existing mature vibrato skill were excluded from the study.

Learning modality is fundamental to sensory preference. Sensory perspectives
of learning are considered a primary component according to Curry (1987) as opposed to learning styles which are more deeply imbedded cognitive structures. Because this study is concerned with learning modality preference and not learning style, it is important to the purpose and validity of this research that an appropriate assessment instrument be employed. The choice to use VARK (Fleming, 2001) was appropriate since it reports sensory mode learning preferences rather than complex learning styles that incorporate environmental factors such as time of day and climate.

**Importance of the study**

One of the primary goals of school string programs should be to improve the quality of instruction on stringed instruments (Hamann, 1998). Furthermore, although technique such as the teaching of vibrato was identified as a primary concern among string teachers, string teaching methods were found to be among the least studied topics in music education research (Nelson, 1983). Kantorski (1995) recognized technique as representing 27.18% of string education dissertations published between 1936 and 1992 and of those, only 5.17% were dedicated to class instruction. The remainder of these dissertations appeared to focus on studio pedagogy. Vibrato is one example of a technique that has received little attention from researchers, specifically regarding how to advance the most promising practices in classroom settings. Furthermore, Reidlinger (2000) claimed existing vibrato tutorial studies to be too subjective rendering them inadequate for advising pedagogical decisions.

Reidlinger (2000) identified vibrato research as being historical, scientific, or
tutorial. The majority of vibrato research that exists has been dedicated to defining and analyzing the acoustic properties of the skill such as functions of frequency, pitch and rate in lieu of teaching methods (Timmers & Desain, 2000). Primrose (1976) asserted that the uniqueness of vibrato and its development deserves a level of persuasive instruction equally diverse to the skill itself that accommodates the individuality of the instrument, the student, and the nuances of the ornament. String playing incorporates visual, auditory and kinesthetic characteristics that suggest learning styles as a viable option for accommodating the uniqueness of learners and promoting skill growth (Nelson, 1983, Campbell, 2007).

According to Zhukov (2007) however, learning styles research in music education is severely lacking, creating an urgent need to investigate how music instruction and more specifically, strings teaching and learning responds to this approach. Kanotrski (1995) suggested that string education could benefit from “the efforts of doctoral students as they initiate and complete the process of writing a dissertation” (p.296), therefore the goal of this study will be to investigate the effectiveness of matching instruction with student learning preferences by comparing student growth with vibrato between those who are taught traditionally and those whose learning preferences are accommodated. Lastly, this study intended to contribute to bridging the chasm between music education, and learning styles pedagogy, as well as augment the body of string instrument technical studies toward satisfying Hamann’s (1998) vision of string programs as agents of instructional improvement.
Chapter II

Literature Review

This study investigated one possible alternative approach to traditional vibrato instruction. Vibrato ranks among the most complex and difficult skills for string players to learn and for non-string players to understand, therefore, the scope of this chapter begins by establishing an empirical definition for vibrato that examines the individual components in isolation. Understanding how these parameters synthesize to produce vibrato assists in comprehending how vibrato quality is assessed. Additionally, a discussion of literature surrounding prevailing vibrato pedagogies and evaluation is included in addition to a review of two studies that specifically investigated methods of teaching and learning vibrato. A discussion of learning styles models and their assessment follows in the latter portion of this chapter culminating in an examination of issues surrounding the controversy of matching and mismatching teaching style with student learning styles.

Historical Perspectives of Vibrato

Leopold Mozart (1787/1985) described “the tremolo” as an ornament closely resembling modern vibrato that produces a “certain wave-like undulation” (p. 203). Until the mid-eighteenth century vibrato was reserved specifically for effects such as embellishing sustained notes and cadences (Boyden, 1950). Although vibrato was appreciatively ornamental, Brown (1988) suggested that vibrato instruction during the nineteenth century was relatively limited due to misunderstanding how the ornament
functioned. As a result, the technique was oversimplified to merely a hand tremble with a finger fixed securely to the fingerboard of the instrument.

Furthermore, in spite of historically being recognized as a prominent performance feature of string playing, vibrato has not always been embraced among violin pedagogues. Prevailing nineteenth century opinions on vibrato tended to be rather suspicious and somewhat caustic. For example, Baillot (1834) advised that vibrato be used sparingly at the risk of potentially destroying the “precious naivety which is the greatest charm” (p.113) of the violin. Berio (1858) issued even more stern advice stating that “this habit, involuntarily acquired, degenerates into a bad shake or nervous trembling which cannot afterwards be overcome and which produces a fatiguing monotony” (Brown, 1988, p. 114). Early twentieth century views of vibrato unfortunately tended to be no less compassionate toward the technique. Leopold Auer (1926), for example, considered vibrato to be a crutch that players rely on to mask poor intonation. Bonavia (1927) deemed vibrato to be “a curse” (p. 1077) that defiles the true beauty of the instrument with which Stewart (1931) agreed, referring to vibrato as the violinist’s “evil habit” (p. 467).

Research conducted at the University of Iowa in the early decades of the twentieth century has been invaluable in apprehending a better understanding of how vibrato functions. Seashore (1931) described vibrato as a systematic fluctuation of sound pulsations that are generated by manipulating four sound properties: frequency, intensity, duration and waveform. Cheslock (1931) however, advised that face value observations of vibrato as solely a product of pitch fluctuation are deceptive; citing the importance of
recognizing that several facets contribute to the effect, none of which operate in isolation of the others.

**Defining Vibrato**

Data collected from Seashore’s early studies have provided a vocabulary for understanding vibrato. Seashore (1931) recognized the behavior of vibrato’s acoustic properties as corresponding to perceptive elements of rate, extent, and shape within an oscillation cycle. Rate pertains to the speed of a vibrato cycle. Extent pertains to the pitch frequencies that define the extreme boundaries of a cycle, and shape describes the directional contour of the oscillation. Consequently, these descriptors continue to be used by researchers and pedagogues in facilitating more precise discussions concerning vibrato more concretely. Verfaille, Guastavino, and Depalle, (2005) acknowledged that pulsation within vibrato cycles is generated by frequency modulation or pitch, amplitude modulation or intensity, spectral enrichment or extent, and finally waveform or shape. Vibrato on stringed instruments is produced by pivoting a finger around a central position on the fingerboard that results in miniscule lengthening and shortening of the string producing causing a frequency oscillation. The momentum of the finger produces low levels of energy allowing the oscillation to be sustained without any additional excitation or fluctuation on intensity of the vibrato cycle as recognized by Seashore (1931) and Verfaille, Guastavino, and Depalle (2005).
**Vibrato rate.**

Cheslock (1931) identified rate as the most prominent feature of vibrato. Measured in cycles per second, rate is influenced by frequency, tempo and duration (see figure 1, Appendix A). Seashore (1937) proposed that “artistic vibrato” (p.31) for stringed instruments should be approximately six or seven cycles per second, coinciding with Metfessel’s (1929) claims of average vocal vibrato rate also being approximately seven cycles per second. Mean rates for violinists studied by Papich and Rainbow (1974) were reported to be 6.5 Hz conforming to Seashore’s (1937) definition of “artistic vibrato” as being approximately six or seven cycles per second. Double bassists in the study demonstrated a dramatically slower rate (4.0 Hz.) however, agreeing with the behavioral relationship of waveform to frequency. Cellists exhibited the most flexibility with this given the instrument’s wide range and subsequently demonstrated the most consistent rate within tempi changes.

Desain, Honing, Aarts and Timmers (1999) reported that all instruments demonstrate a tendency to accelerate vibrato rate as tempo increases although no evidence of a reciprocal relationship was found when decreasing tempo. Perhaps this is because performers tend to control rate more steadily when increasing speed but struggle with sustaining continuity as rate slows which implies that a “dominant” rate that persists throughout a vibrato cycle (Schlapp, 1973. p. 363). Changes in rate have a direct corollary effect on extent because oscillation speed depends upon the distance between its boundaries in order to maintain regular pulsation. “When the tempo increases and thus the note length decreases; the vibrato rate has to increase” (Desain, Honing, Aarts and
Timmers, 1999). Severing the partnership between rate and extent potentially destroys the fluidity of the oscillation, supplanting it with a wobble (Metfessel, 1929). In studies by Schoonderwaldt and Friberg (2000), and Timmers and Desain (2000), the tendency for extent to narrow was associated with an increase in rate as the duration of a sustained vibrated pitch approached its conclusion. Bretos and Sundberg (2002) compared rates among ten soprano vocalists and observed similar circumstances regarding the behavior of rate, extent and tempi concurring with previous research. Research has been inconclusive however about the dominance of either extent or rate in a vibrato cycle. Corso and Lewis (1950) investigated rate and extent preferences among musically trained and untrained subjects and found that vibrato preferences seemed to depend more on extent than rate, however, concluding later that rate was more influential than extent on vibrato perception especially when it differs from that of a reference pitch.

**Vibrato extent.**

Extent describes the range of pitch fluctuation between the boundaries of the most extreme frequencies of a pitch oscillation coinciding with the width of a vibrato cycle (see figure 2, Appendix A). Seashore (1931) explained extent as the “distance between the top and bottom of the crest, expressed in fractions of a tone” (p. 624). According to Seashore (1931), 50% of extents for instrumentalists fall within 0.4 to 0.8 Hz. of a tone. Artistic vibrato extents according to Cheslock (1931) should not exceed a quarter tone in width although in some instances however, fluctuations ranging from 0.1 to 1.0 Hz. of a tone have represented the most extreme boundaries (p. 624).
Papich and Rainbow’s (1974) included vibrato extent in their investigation of performance practices among string instrumentalists. Participants were asked to perform as soloists and within ensembles to compare how technique was applied in both contexts. Extent was found to be consistent, regardless of the performance setting, where the average extent spanned from 0.13 to 0.25 of a tone, conforming to Seashore’s parameters of “good vibrato.” Although performance setting was observed as minimally effecting extent, other factors were found to have greater influence on it. Both Cheslock (1931) and Reger (1932) found that extent consistently increased as tonal intensity increased. Timmers and Desain (2000) observed that metric stress corresponded to weighted beats during an oscillation cycle. The researchers cited the correlation between metrical stress and increased extent as a possible “communication of metrical level” (p. 9). At one point, extents among instruments were thought to be relatively equal as noted by Reger (1932). Geringer and Allen (2004) discovered however, that extents of violinists tended to be wider extents (34 cents) than cellists (26 cents). Furthermore, second and fourth fingers were found to produce slightly wider extents (30 cents) than first fingers (27 cents).

**Vibrato shape.**

Shape describes the contour of the wave or direction in which pitch fluctuation travels during a vibrato cycle, (see figure 3, Appendix A). Geringer and Allen (2004) believed shape to be perhaps the most debated aspect of vibrato, perhaps because it has the greatest influence on intonation. Fischbach (1998) explained that string teachers have differing opinions about initial direction of a cycle shape, where some believe it to be
above a pitch, while others believe that the oscillation begins by moving below the fundamental pitch. Papich and Rainbow (1974) identified tendencies among musicians to vibrate upward, above the original pitch as characteristic of vibrato that they studied. Later studies by Nelson (1983) and Brown (1991) supported this agreeing that musicians tend to oscillate above a given note and reserve the true fundamental pitch as the bottom of the cycle. Correct vibrato according to Lucktenberg (1994) should vibrate below the original pitch however, disagreeing with prior research citing that the ear will gravitate to the highest frequency heard in the vibrato cycle as the fundamental as opposed to the lowest. Vibrating above a pitch therefore could imply an illusion of false intonation. Shonle and Horan (1980) and Brown and Vaughn (1996) agreed however, that intonation is perceived by synthesizing the mean pitch fluctuation and therefore, directional intention above or below a given frequency is inconsequential to pitch perception. This suggests that theoretically unidirectional vibrato should yield false intonation as either sharp or flat from true pitch. Recently, Geringer, Allen and MacLeod (2005) studied initial direction among high school and university violinists and cellists and found no clear consistencies in pitch direction. Cycles initiated upwards (N = 84) were nearly identical in number to those beginning in a downward direction (N = 76), supporting Brown and Vaughn (1996) that initial direction tends to be a matter of artistic preference more than a perceptual function.

Seashore (1931) identified four illusions that muddy the clarity of vibrato, the first being an underestimation of extent as being smaller than it actually was. Second, is the misconception that vibrato originates from pitch fluctuation or pulsation intensity. Pitch
perception was the third illusion where oscillations even as wide as a semitone may meld into a “unified tone” and create a false intonation (p.626). Goodwin (1977) agreed indicating that successive oscillations may indeed fuse into the illusion of an inaccurate definite pitch center. Geringer and Allen (2004) noted tendencies for musicians to adjust intonation more frequently when not vibrating than during vibrato cycles suggesting that vibrato was an easy medium in which to camouflage faulty intonation. According to Verfaille, Guastavino, and Depalle, (2005), the ear has the ability to discern pitch accurately and independently of vibrato conditions.

Instrument size and pitch range also plays a significant role in the relationship between vibrato pitch, rate and extent. Papich and Rainbow (1974) found an association between vibrato rates and instrument register, reporting that violins vibrated at 6.5 vibrato cycles per second; whereas cellos and basses vibrated at 5 vcps and 4 vcps respectively. Data from this study agrees with behavioral characteristics of frequency and waveform where higher pitched instruments with thinner strings tend to vibrate more rapidly than lower pitched ones with thicker strings. MacLeod (2006) suggested a similar association between extent, instrument size, and string length however found that overall, violinists demonstrated a wider vibrato extent than did violists and cellists, with which Geringer and Allen (2004) concurred.

**Vibrato Pedagogy**

MacLeod (2006) claimed that string musicians tend to be apprehensive when explaining the details of vibrato performance despite being adept at performing it
themselves. Historically, vibrato instruction has been primarily non-verbal and largely guided by modeling where the teacher demonstrated the skill and the student emulated it (Lee, 1999). Many treatises on violin performance exist that have been authored by respected string pedagogues such as Leopold Auer, Ivan Galamian, Yehudi Menuhin, Carl Flesch, Samuel Applebaum, and Paul Rolland, whose ambition have been to discuss philosophical perspectives of developing violin technique. Nelson (1983) noted, however, that ideas presented in these texts tend to be more suitable in a private studio environment than for use in a class, because the focus of this literature is grounded in traditional mentorship and essentially imitation.

Perhaps the most undisputed facet of vibrato is that instruction should be preceded by appropriate hand and arm preparation (Galamian 1948, Young, 1978, Lucktenberg 1994, Rolland 2000). Among the most prevalent requirements cited by string teachers is the development of a relaxed and tension free left hand position. To varying degrees other traits, such as finger strength and coordination, should be considered as well as the ability to play in tune (Young, 1978). Applebaum (1986) suggested that the ideal vibrato is a balanced combination of finger, hand and arm motion cooperating in concert with each other. Fischbach (1996) believed that a limited view of the physical attributes of vibrato as only the left arm is restricting and recommended that teachers recognize a holistic view of the player citing that “string players are bodies in motion” (p.2).

Although vibrato is attributed to being universal to all stringed instruments, the physical execution of it is largely governed by the specific instrument that it is being performed on. The violin and viola share similarities mostly due to their sizes and posture
requirements. Likewise, similarities can be found between the cello and the bass for the same reasons. Foremost, the position in which each instrument is held requires a different approach from the player which in turn engages different parts of the left arm in the vibrato process. Practically all violin and viola teachers recognize vibrato as belonging to one of three types, finger, hand or wrist, and finally arm vibrato (Galamian 1948; Applebaum 1986). Applebaum (1986) explained however that each type is not exclusive and still depends upon participation of the whole arm in the process. “With the hand vibrato, there is a sympathetic motion of the forearm. With the arm vibrato there is sympathetic motion of the upper arm. With finger vibrato, there is sympathetic motion of the hand” (p.64). For this reason introducing vibrato in third position on violin and viola is a popular approach largely because it encourages free symmetrical range of hand motion as the finger pad pivots. Dillon and Kriechbaum (1978) recognized that although all three types will be inadvertently used during performance, one will inevitably rise to dominance according to the performer’s preference.

The size and orientation of cello and bass offer fewer choices for producing vibrato. Vertical position coupled with an exaggerated distance between pitches on the fingerboard make finger vibrato virtually impossible as noted by Mantel (1975). Wrist or hand vibrato is possible on the larger instruments however not until approaching the thumb position in the extreme upper register where the proximity of the pitches becomes conducive to a smaller amplitude and faster rate. Mantel (1975) advocated an upper arm vibrato on the cello with which Young (1978) agreed explaining that free mobility of the elbow is paramount to achieving an expressive vibrato on the cello. Morton (1991)
described a similar approach to double bass vibrato citing that “never should the arm twist through supination and pronation or through a bending of the wrist, but the arm should remain as a single unit from the elbow to the tip of the finger” (p.86).

**Method books.**

Young (1978) believed imitation alone is insufficient to teach vibrato because most individuals are unaware of the role of specific muscles in executing the range of motion specific to vibrato. Fowler (1987) agreed noting that “some students many require (more) explicit instruction in the detailed mechanics of vibrato” (p. 29). Therefore to facilitate understanding the overarching complexity of vibrato, Young (1978) suggested isolating individual technical components through an array of innovative original games and mental images such as pretending that the left elbow is floating in imaginary water while allowing the left hand to shake like Jell-o. Lucktenberg (1994) however, recommended more musically deliberate exercises that engaged students in exploring the semitone range of motion within prescribed repetitive rhythmic trill-like patterns.

Despite Waller’s (1944) opinion that all left hand techniques are teachable in a group environment, Nelson (1983) asserted that “string class teaching is often based on the pedagogy developed in the studio” (p.39) which renders it impractical for large groups and classes. Consequently public school string teachers are challenged with designing and delivering effective instruction that is suitable for large heterogeneous classes. Many publishers offer group method book series designed specifically to facilitate the flow of instruction in a large rehearsal classes. Reidlinger (2000) recognized
five popular class string methods as including vibrato instruction in their texts. The
*Muller Rusch* (1961) method is a four volume series that introduces vibrato in the second
book as a succession of exercises entitled, *Swing into Vibrato*. The approach employs
five steps including establishing vibrato readiness or pre-vibrato training, where the
student assumes a left hand playing position away from the instrument and waves back
toward him or herself. The second step applies the motion to the instrument in guitar
position to facilitate self-monitoring of the motion. The third step requires the student to
repeat step two however, this time placing the second finger on the D string allowing it to
slide as if polishing the string. Step four builds on this range of motion by asking the
student to repeat step three however, firmly anchoring the second finger and not sliding.
The final and culminating step places the student into playing position and sets the left
hand into third position to encourage a good hand shape and appropriate arm posture for
executing the motion practiced in the preceding step and thus produce vibrato.

Unlike, *Muller Rusch* (1961) in which vibrato prefaces shifting into advanced
positions, *String Builder* (1960) reserves vibrato until the third volume of the series
concurrent with shifting and position exercises. Applebaum’s approach bears a
resemblance to Lucktenberg’s (1993) by ascribing a rhythmic association with the
performance task. Pre-vibrato exercises include one to two weeks of moving the wrist
back and forth to a variety of eighth note, triplet, sixteenth note and dotted
eighth/sixteenth note patterns. *String Builder* introduces the application of motion on the
instrument in third position immediately to cultivate appropriate hand and arm shape,
agreeing fundamentally with the *Muller Rusch* (1961) method.
All for Strings (Anderson & Frost, 1986) introduces vibrato in volume two with a substantially more elaborate series of exercises than in either of the two preceding texts. Two fundamental components identified by Anderson and Frost are, finger strength and finger relaxation. All for Strings (1986) embraces philosophies described by Young (1978) and Lucktenberg (1993) targeting finger strength development via trill and grace note exercises in addition to left hand pizzicato studies. These exercises promote muscle relaxation through “finger slides” that involve semitone movement within a prescribed rhythm, mirroring the string polishing imagery found in Muller Rusch (1961).

Essential Technique (1997) as the third volume of the Essential Elements series devotes three pages to vibrato development imbedded within a section of the text reserved for advanced techniques like specialized bowings. In addition to an elaborate collection of pre-vibrato exercises, this method advocates the importance of flexibility in the first knuckle joint and details the specific treatment of hand, and arm vibrato as unique mechanisms. Since its debut, revisions to the method have yielded the most current edition, Essential Technique 2000 (2002) with the addition of DVD media with each copy as model readily available to the student. String Explorer (Dabczynski, 2002) is perhaps the latest method book to address vibrato development introducing it toward the start of the second volume in the two book series. The book presents a compilation of developmental exercises similar to the others, however, deliberately employing the four note motif from Dies Irae as a suitable excerpt for developing vibrato largely because of the lengthy sustained notes provide a prime opportunity for exploring and refining vibrato motor skills and sound quality.
*Viva Vibrato* (1998) authored by Fischbach and Frost, was the first method of its kind dedicated exclusively to the development of vibrato. Divided into four sections, *Viva Vibrato* (Fischbach, 1998) supplements the acquisition of the skill with material to develop musicality and vibrato maturity. The first section entitled, “*Vibrato Readiness,*” begins with establishing preparedness through a series of pre-vibrato exercises. It is followed by the second entitled, “*The Birth of Vibrato,*” that introduces the principles of motor coordination that will eventually develop into vibrato motion. The third section “*The Developing Vibrato,*” applies the practiced motion on the instrument in context using melodic passages, and finally “*The Maturing Vibrato,*” as the culminating fourth section synthesizes vibrato technique with other advanced techniques.

In spite of a well-organized and visually engaging text, acclaimed cellist Irene Sharp criticized the book as a “bright, attractive, instructive manual for beginning students,” whose appeal fades quickly through the “gimmicky language” (Sharp, 1998). According to Sharp (1998) *Viva Vibrato* (Fischbach, 1998) overemphasizes the methodical versus intuitive lens to vibrato instruction. She contended that:

if the left hand is balanced, vibrato will happen by itself. The student must be aware that the left hand plays the notes and the left arm moves the hand. Therefore the finger only moves in response to the movement of the arm, and not of its own instigation” “I think they miss the basic needs of producing a fine vibrato: knowing what sound you want to produce and knowing how to produce it, (Sharp, 1998, p.1).

Regardless of their position within string education curricula for decades, historically
method books have been subject to critical scrutiny. Rolland and Cowell (1966) observed that the preoccupation of methods with technical issues renders them inferior for developing natural physical responses necessary to acquiring solid performing skills. Kerner (1969) concurred stating that relying on printed material alone is instructionally inadequate because as novices encounter new skills, they need definitive instruction and ample opportunities to explore and personally experience what they have observed.

**Pedagogical vibrato studies.**

The majority of pedagogical vibrato research has concentrated heavily on identifying acoustic properties of the skill. Timmers and Desain (2000), for example, recognized that vibrato literature appears to be dominated by diagnostic or perceptive studies such as Geringer and Allen (2004), or Verfaille, Guastavino, and Depalle (2005) whose focus is concerned with analyzing behavioral patterns of vibrato components like rate, width (extent) and directional intent (shape) either from the performer’s perspective, or the audience’s point of view. The imbalance of acoustic studies versus pedagogical studies was cited as a major limitation to the utility of vibrato research as an instructional resource because there appears to be inadequate support for advising the most effective instructional approaches. In a review of vibrato research, Geringer, Allen, and MacLeod (2010) admitted that the crux of vibrato literature is devoted to acoustic research that may peripherally guide teaching although it is not primarily intended to do so. Therefore minimal pedagogical literature seems to have contributed to confounding vibrato instruction or discouraging it altogether. Furthermore, vibrato tends to receive lower
priority among many string teachers than rudimentary issues like bowing and intonation that are more urgent to concert performances. Additionally, those who do persist with addressing vibrato frequently tend to emphasize introducing the skill more than cultivating its development, operating on the assumption that progress will come naturally as students rehearse basic vibrato technique. Vibrato is far too complex a skill to be left unattended during its development. The lack of adequate models and monitoring potentially endangers technical development and hinders the aesthetically pleasing sonority associated with string vibrato. Therefore, it is imperative to investigate options that support instruction, and are realistically manageable within a teaching schedule.

Among the existing body of vibrato research literature, two studies were identified as specifically targeting vibrato instruction as opposed to diagnosing or analyzing vibrato characteristics. The first study was inspired by a review of pedagogical vibrato literature conducted by Reidlinger (2000) which concluded that the subjectivity of existing research was unreliable and inadequate for supporting a systematic approach to the teaching of vibrato. Reidlinger (2000) asserted that string teachers have failed to reach consensus regarding the development of an effective practice for teaching students vibrato. Therefore, in an effort to examine agreement between method books and investigate the proposed time frame for a course of vibrato instruction, Reidlinger (2000) compiled vibrato lessons from three popular method series, Mueller Rusch (1961), Essential Elements (1997) and Viva Vibrato (1997) as the basis of instruction. Over a period of four weeks, subjects received daily lessons that introduced vibrato concepts in
four stages mirroring the phases of skill development that Reidlinger (2000) identified as common within vibrato literature as, pre vibrato preparation, motion development, initial vibrato training and mature vibrato training. Exercises were borrowed from three prominent string class method series and lessons spanned an average of 15 to 20 minutes per day. Students’ individual progress was recorded at the conclusion of weeks one, two and four. Upon completing the study, recordings were submitted to a panel of seven string educators for evaluation using Gillespie’s (1993) own vibrato evaluation form.

Recorded data was organized into three groups corresponding to week one (A) week two (B) and week four (C). Subjects’ individual recordings from weeks A, B, and C were evaluated consecutively by the judges and two categories of scores were produced. Category I scores represented a sum of individual vibrato component scores, (width, speed, evenness, and pitch stability), and Category II represented overall vibrato quality scores. Reidlinger (2000) reported mean scores for category I scores to be A = 43.5, B = 57.15, and C = 91.8 out of a possible 140 points, indicating that vibrato quality improved through the duration of the study. Category II scores were reported as 10.15, 13.95 and 24.60 consecutively, supporting the conclusion that vibrato quality improved during the study.

In spite of favorable conclusions, inconsistencies in this study appear to have compromised its clarity. The purpose of this study was to investigate common characteristics and teaching strategies among some popular classroom method books that teach vibrato. Reidlinger’s (2000) hypothesis however appeared disconnected from his purpose postulating the length of time that a student would need to study vibrato in order
to develop it rather than address a possible relationship among the methods. Furthermore, the first reference to the hypothesis appearing in the abstract states that, students require at least four weeks to develop correct vibrato. Later in Chapter 4, however, Reidlinger’s discussion of the results recalled an expounded hypothesis that specified where developmental growth spurts were expected to occur although no prior mention of this was part of the original hypothesis. Data analysis reported that scores in both categories I and II improved throughout the duration of the study. This is a logical expectation for students who participate in any structured course of instruction therefore the effectiveness of method books or the similarities between them remains unclear because no other variables such as guided exercises or was introduced in comparison.

Reidlinger’s study shares several fundamental aspects with my study, first, that both investigate effectiveness of presentation modes for vibrato instruction. Whereas Reidlinger (2001) examined differences among printed method series, Varga’s study sought to recognize the effectiveness of a learning styles approach to teaching vibrato whereby instructional material in the method book is transposed and interpreted to accommodate each group’s specific sensory learning strategy. Therefore, Varga’s study involved two levels of pretest, one to assess existing vibrato skills, and on to identify individual proclivities toward learning. A major departure between the two studies though resided in the length of the intervention period which Reidlinger enacted lessons that averaged between 15 to 20 minutes per day, for four weeks. Varga’s study conversely engaged each of the four participant groups in 15 forty five minute lessons over the course of six weeks. Doing so significantly augmented the treatment period and
helped to strengthen the credibility of the data collected. Finally, both studies shared a common assessment using Gillespie's (1993) vibrato evaluation.

More related to the present study, a second study by Shepherd (2004) approached a learning styles strategy by exploring the effectiveness of video based instruction to reinforce vibrato acquisition among seventh and eighth grade string players. The introduction of visual media to promote skill development coincides with fundamental principles of learning styles by augmenting the presentation mode. Shepherd (2004) studied 240 middle school string students for a six-week duration, where both the experimental and control groups received videotapes for instructional purposes. The experimental group was provided with videos that modeled aspects of proper vibrato performance whereas the control group videos demonstrated only deliberate finger patterned exercises. Research variables included vibrato rate, width, evenness, pitch stability, and overall quality as prescribed by Gillespie’s (1993) vibrato evaluation. Posttest performances were recorded and reviewed by a panel of four judges using an evaluation tool adapted from Gillespie (1993) and data was subjected to two 2x2 multivariate analysis of variance which were succeeded by 10 2x2 analyses of variance tests. Results indicated that the experimental group outperformed the control group in all of the evaluative categories except pitch stability. Furthermore, experience appeared to influence performance where students with advanced skill development outperformed intermediate students. In only one instance did the intermediate students outperform advanced students demonstrating evenness of vibrato throughout the entire passage. Additionally, 85% of control group subjects cited the videos as being helpful to learning
vibrato whereas 95% of experimental subjects admitted that the videos were helpful. Slightly more than half of control subjects (58%) claimed that they would continue practicing with videos after the study as opposed to 82% of experimental subjects who admitted that they intended to continue practicing with the videotapes. In conclusion, Shepherd (2004) stated that video based instruction yielded an overwhelming 95% approval rate among middle school students as being helpful because it held more student interest than finger pattern exercises. MANOVA analysis found that subjects who participated in the video instruction (N = 22) also performed vibrato at a superior level (M = 9.50) compared to those instructed by exercises alone (N = 17, M=6.76) (Shepherd, 2004).

Data from Shepherd’s (2004) study support that video based instruction holds advantages as an instructional model for some students to reinforce vibrato exercises presented in class; however, employing this approach to the exclusion of others can be limiting to those who do not favor visual or auditory learning. Both the experimental and control groups were provided with videotapes operating on an assumption that the visual and audio modes of presentation are superior to kinesthetic for supporting vibrato instruction; though audio-visual presentation alone does not encompass the full gamut of strengths and preferences that exist within a typical classroom. According to Barbe and Milone (1981), typical learning modality distributions resemble 30% visual, 25% auditory, 15% kinesthetic, and 30% combined. Therefore, audio-visual presentation to the exclusion of kinesthetic theoretically benefits only 85% of students while hindering or neglecting the 15% minority who learn best through hands on approaches. Kinesthetic
learning involves the transfer of knowledge through motion and tactile activity. For a kinesthetic learner, information is most effectively absorbed and processed through action and movement, just as the audio or visual learner accesses information best through listening or viewing respectively. Movement in the control group of Shepherd’s (2004) study was not active in the sense that it is for a kinesthetic learner, but merely a response to presentation stimuli involving traditional method vibrato exercises that are modeled for students. My study however, sought to construct experiences that stimulated each of the primary learning modalities identified by Barbe and Milone (1981).

Furthermore, Shepherd (2004), claimed that method books alone are not sufficient for supporting accurate recall of vibrato exercises to be practiced outside of the classroom and therefore without an appropriate prompt, the effectiveness of home practice is compromised. This study examined teaching vibrato in a manner that is personally and intellectually meaningful and has the potential to bolster comprehension as well as strengthen retention. Shepherd’s (2004) model by contrast is marginally concerned with presentation mode as it is with presentation method relying on modeling as a chief vehicle for the transfer of knowledge. Modeling is a fundamental component of Social Learning Theory (Bandura, 1989) and while it remains a fundamental approach to teaching skills, it relies heavily upon self-directed discovery to bring meaning to the skill and does little to support connections between action and thought beyond mimicry. Horner, Bhattacharyya, and O’Connor (2008) recognized that patterns of thinking for example are not observable; therefore, some things may not be teachable through modeling. Learning styles by contrast offer an expeditious avenue for synchronizing
thought vis-à-vis, relevance with action. By addressing each of the three primary sensory modes, visual, auditory and kinesthetic, this study suggested an inclusive design that could extend the benefit of presentation mode to 100 percent of the learner population.

**Alternative approaches to learning vibrato.**

According to Mueller, (1996) “vibrato is one string technique which is often discussed in professional workshops, clinics, and journal articles but, it is not consistently required in the string education curriculum” (p.65). The ongoing debate of how and why vibrato should be taught has inspired considerable ambition among string educators to seek alternative approaches to teaching vibrato. MacLeod (2006) cited that “inconsistencies between various studies and pedagogical philosophy indicate that additional study is necessary before teachers can accurately articulate how the vibrato functions in a variety of musical contexts” (p.38). In the *Proceedings of the Third International Technological Directions in Music Education Conference*, Mueller (1996) asserted that educational technology might be an ideal option for supplementing traditional teacher mediated instruction introducing *Visualized Vibrato*, a hypermedia program allowing students to access a 13-step vibrato instruction sequence. Each hypermedia card of the program includes a QuickTime video clip that the student can replay and review at will. Additionally, a supplemental scrolling text narration accompanies the video that can help interpret details of the video for clarity if needed. The design of *Visualized Vibrato* according to Mueller (1996) empowers the learner with freedom to control the learning environment. Although targeted to the university level,
Mueller (1996) contended that the program is equally suitable for use in the public school setting among string classes. The advantage to such media is that it provides students with a solid consistent model that can be accessed at will as opposed to limitations imposed by the schedule of the class. Mueller (1996) did express concerns, however, regarding QuickTime technology and the availability of adequate hardware requirements to implement such a program on a wide scale.

Several concerns surface as a result of using computer based instruction for teaching vibrato. Foremost is an issue that Mueller (1996) recognized, whereby this method may not be logistically feasible for some school districts to implement due to the lack of adequate technology to support such a program. Furthermore, an instructional program that depends upon this level of technology may not be cost effective for a school district to adopt therefore, limiting the accessibility of its benefit to students. A third concern arises regarding the learning curve for students with operating the software. Despite the assumption that most students in public schools are adept with navigating technology, employing computer media for this purpose requires additional instruction to teach proper use of the software. According to Mueller (1996) one of the advantages of Visualized Vibrato is that it enables the student to control the learning environment; however, this also relies heavily upon the self-efficacy (Bandura, 1989), of the student to manage learning independently which may be difficult for field dependent learners. Among a middle school population, this can be problematic as Prashnig (2012), recognized citing grades seven and eight as a nadir in student motivation. Lastly as Zywno and Waalen (2002) indicated, although education literature asserts hypermedia
instruction as demonstrating multi-modal characteristics, capable of accommodating a wider range of learning diversity compared to conventional instruction, there is still little empirical research supporting this claim.

**Evaluation of Vibrato**

According to Cowell and Goolsby (1992), “evaluation is the keystone of the teaching process” (p. 25). Efforts to establish objective standards for vibrato evaluation have persuaded pedagogues to rely on empirical acoustic characteristics to constitute equitable assessment. Seashore’s (1937) early studies provided criteria for measuring vibrato recognizing rate, extent, and shape as its primary components. Despite the acceptable parameters defined by such studies, assessing vibrato qualities beyond the behavior of its acoustic elements retains a high degree of subjectivity. Therefore the development of educational based rating criteria has been helpful with evaluating the artistic quality of vibrato in performances.

In the late 20th century, Gillespie (1993) devised a vibrato evaluation instrument based on an earlier model that he designed in 1991 to assess détaché bowing among student violinists. According to Gillespie (1993), vibrato quality could be evaluated by identifying the five characteristics, width, speed, evenness, pitch stability, and overall sound quality. Width and rate correspond directly to what Seashore (1931) called extent and rate; however, evenness describes a performer’s ability to control width and speed in appropriate context to a musical passage. Pitch stability and evenness describe the performer’s ability to maintain pitch center during the vibrato cycle and not suffer faulty
intonation as a consequence of vibrato. Overall vibrato sound refers to a composite score value summarizing the assessment of the other four factors. Gillespie’s (1993) vibrato evaluation form employed a five point Likert-type scale on which to rate each of the identified performance factors, where one represented unacceptable and five signified excellence. Zdzinski and Barnes (2002) piloted a similar string performance rating scale in which vibrato was included as one of the elements and the evaluative vibrato criteria identified by Zdzinski and Barnes (2002) coincided with the evaluative vibrato criteria identified by Gillespie (1993).

Gillespie (1997) later investigated the influence of presentation media on perception during vibrato evaluation. In this study Gillespie (1997) asked a panel of judges to evaluate two groups of string players using audio only and audio-visual recordings. The two groups who participated in this study consisted of 28 experienced music majors at The Ohio State University, and 33 novice musicians who had been given a ten day course of 15 minute vibrato lessons. The recordings were presented to the panel in three phases to isolate variables and judges were asked to evaluate the recordings using Gillespie’s (1993) vibrato evaluation instrument.

Phase one consisted of video recordings of the novice group only. One month later, the second phase presented videotapes of the experienced players accompanied by randomly sorted audio tracks of both groups. Six months later, the third and final phase involved viewing videos of the experienced players accompanied by random audio tracks from both groups. Gillespie (1993) concluded that audio-visual combinations provided “more stimuli than do audio-only modes” (p. 218). Gillespie’s (1993) findings support
the importance of holistic sensory stimuli in learning as recognized by Barbe and Milone (1981). Subscribing solely to audio-visual presentations however, neglected 15% of the student population who Barbe and Milone (1981) identified as kinesthetic learners.

Furthermore, the criteria upon which Gillespie (1993) based his evaluation form are inherently kinesthetic and therefore should not be underscored by the other two sensory modes. An intricate relationship exists between motor skill and sound quality regarding vibrato shape, width and rate whereby the sonority produced immediate reports feedback that is valuable to monitoring and controlling the oscillation. Although other aspects of string playing such as intonation, articulation and rhythm are also subject to the similar scrutiny, vibrato is unique in that the motion is continuously sustained throughout the duration of performance unlike intonation that may be adjusted and settled upon when correct. The current study addressed all three primary sensory learning modalities, acknowledging the gamut of learning preferences that exist in a classroom. Additionally, this study intended to utilize Gillespie’s (1993) vibrato evaluation form, and his criteria used to categorically define vibrato.

Alternate means of evaluating acoustic characteristics of vibrato include analytical software such as PRAAT (Boersma, 2002). PRAAT is a speech analysis software program designed by Paul Boersma and David Weenink, at the Institute of Phonetic Sciences, University of Amsterdam. Although named for its original purpose as a phonetic speech analyzer, (PRAAT is Dutch for talk), it was found to be equally appropriate for musical application because of the manner in which it performs rapid frequency analysis via autocorrelation (the identification of a fundamental frequency
resulting from correlation of multiple harmonic frequencies within a single sound signal) method of periodicity detection (Boersma, 2002). The suitability of PRAAT as an evaluative tool for music was demonstrated by Geringer and Allen in 2004 with analyzing vibrato qualities among university and high school violinists and cellists. Geringer, Allen, and Macleod (2008) employed it again to examine the initial movement and continuity of vibrato among high school and university string musicians finding it to be an appropriate means of sonic evaluation.

Learning Styles

The lack of a standardized teaching method has done little to promote vibrato as worthy of being included in a classroom or rehearsal curriculum. Apprehension stemming from the complexity of vibrato performance has discouraged many teachers from pursuing it as a teachable component in their curriculum. Dickey (1991) suggested that perhaps sensory learning models might be a compatible option for addressing such skills citing sensory models as appropriate for advancing virtually any technique that is encountered in an instrumental ensemble.

Defining learning styles.

Learning styles is an umbrella label employed among psychologists and educators to embody the plurality of information processing models. Felder and Silverman (1988) for instance regarded learning styles as an individual’s predilection toward specific mental operations during the reception and processing of information. Reynolds and
Gerstein (1992) however described learning styles as representative characteristics or preferences for learning. Furthermore, Cassidy (2004) suggested that learning styles represent the “application of cognitive style in a learning situation” (p. 420), with regard to individual habits of perception, problem solving and memory.

Hartley (1998) distinguished between cognitive style, learning style and learning strategies as three related though definitively separate characteristics. Cognitive style refers to an individual’s favored approach to intellectual tasks such as problem solving. Learning style pertains to unique habitual propensities demonstrated during the acquisition and processing of information, whereas learning strategies concern study tactics as supported by Entwistle and Ramsden’s (1982) work that espoused a holistic organizational approach to learning in lieu of isolating cognitive or intellectual processes. While styles and strategies mutually contribute to one’s personal learning identity, Hartley (1998) distinguished styles to be more intuitive and intellectually embedded as opposed to strategies which are more consciously within the deliberate control of the individual. Furthermore, Keefe (1985) suggested that learning styles are a reliable lens to understand how individuals negotiate learning.

**Theories of learning style models.**

Curry (1983) posited a stratified learning model analogous to the imagery of an onion in which dimensions of learning and cognitive processing are sequentially layered. Curry’s Onion Model recognizes three hierarchical dimensions of learning as instructional preference, information processing, and cognitive personality style (Curry,
Instructional preference as the outermost layer is highly dependent upon extrinsic conditions, and represents the least stable and most susceptible to modification over time. Information processing, the middle layer, involves a series of more complex mechanisms demonstrating “the individual’s intellectual approach to assimilating information” (Curry, 1983, p. 8). Curry (1983) maintained that information processing can be flexible; however, its independence from environmental factors renders it more reliable and stable than instructional preferences. Cognitive personality style resides within the innermost layer of the Onion Model and is considered to be the most permanent trait of learning.

Coffield (2004) identified five families of learning style theories using criteria corresponding to Curry’s model as “constitutionally based, cognitive structure, stable personality type, flexibly stable learning preference, and learning approaches and strategies” (p. 21). According to Coffield (2004), constitutionally based theories represent the family with the most stability and permanence. Dunn and Dunn (1984) recognized the alliance between styles and biological factors identifying 20 variables that included time of day, temperature, motivation, peers, impulsiveness, and reflection. Along with 14 others, these were classified as relating to emotional, physical, social, psychological, and environmental factors considered by Dunn and Dunn as catalytic to learning (Dunn, 1984). Similarly, Gregorc’s Style Delineator (1984) concurs with Dunn and Dunn presuming that learning traits are biologically determined and fixed, identifying learners as concrete, abstract, sequential, or random (Coffield, 2004).

Learning styles that are constitutionally based are thought to be propensities toward action or behavior. Theories that support constitutionally based learning styles
recognize genetic and personality traits as influential to learning such as cerebral dominance and sensory preferences. Barbe, Swassing and Milone (1979) for example recognized three primary “modes” of learning based on the use of one’s sensory perception stating, “a modality is any of the sensory channels through which an individual receives and retains information” (p.1). According to Barbe, Swassing and Milone (1979), educators have historically regarded the senses as the gateway to learning. Pestalozzi, for example, advocated attending to the sensory needs of his pupils. He supported the notion that “sense was the basis of all knowledge” and that “the key to education was in taking control of the child’s sensory experience” (Barbe, et al., 1979, p. 20), and agreeing with Montessori’s self-directed approach to “first educate the senses, then educate the intellect” (Barbe et al., 1979, p.22). Given (1996) acknowledged the value of sensory education suggesting that “a modality approach has high face validity because of its practical clarity” (p. 19).

Multiple Intelligences (MI) are peripherally associated with learning styles in that intelligence pertains more to an intellectual capacity for acting on knowledge rather than an avenue for gaining it. Therefore, MI represents an example of what Coffield (2004) recognized as cognitive structure. Cognitive structure theories propose that learning is intellectually embedded rather than being merely habits of action. Gardner (1985), for example, did not suggest specific learning archetypes or processes; however, he proposed the plurality of intellectual dimension from which specific strengths are likely to emerge, resembling learning styles. One of the most prominent theories of cognitive structure is Witkin’s (1962) field dependence/independence that distinguishes between learners who
rely on structure being provided for them versus those who are adept at creating structure independently. Heavily based upon Jungian philosophy, theories of stable personality type have less to do with learning than they do with character temperament.

Stable personality types share an indirect association with learning styles as well because they concern themselves more as predictors of attitudes and behavior based in Jungian psychological archetypes than learning potential (Coffield, 2004). Accordingly, personality models such as Myers-Briggs have minimal influence in the educational arena but are widely embraced as evaluative tools in other sectors such as public business and management. Coffield (2004) identified flexibly stable learning preferences as those learning characteristics that remain relatively static for long periods, yet still retain a degree of malleability allowing them to change under certain situational conditions similar to the middle layer of Curry’s Onion. Among the theories ascribed as flexibly stable Coffield (2004) is Kolb’s (1984) experiential model. Rooted in the work of Dewey and Piaget, Kolb believed that knowledge is a direct corollary of experience. As Kolb (1984) explained, “ideas are not fixed and immutable elements of thought but are formed and re-formed through experience” (p. 26). The Kolb model describes learners within a quadratic paradigm as exhibiting dominant characteristics of, assimilators, convergers, divergers, or accommodators. Bisecting axes define the paradigm where the X axis represents the processing continuum with active experimentation and reflective observation at its poles, and a Y axis depicts the polarity of concrete experience and abstract conceptualization. Similarly, McCarthy’s 4Mat model was also recognized by Coffield (2004) as flexibly stable. Closely resembling Kolb’s design, 4Mat identifies
dominant learning traits as belonging to one of four categories, creative, abstract, practical or proactive (Sarasin, 1999).

According to Coffield (2004), learning approaches and strategies define the avenues of problem solving skills that individuals employ. Coffield (2004) cites the serialist and holist learners of Pask’s (1976) theory as examples corresponding to learning approaches and strategies. Serialists for example process things sequentially in parts as opposed to the holist who considers the big picture to arrive at a conclusion. Furthermore, learning strategies appeared to coincide with the instructional preference layer of Curry’s (2000) Onion model and were recognized by Coffield (2004) as the least rigid family of learning styles.

Assessment of learning styles.

Designing and implementing learning styles based instruction begins with recognizing the dispersion of learning diversity among students. Accomplishing such a task requires teachers to assess the learning style landscape of their classrooms. Plurality of learning styles theories has generated somewhat of a market for teachers from which to shop when selecting a learning styles assessment tool. With a wide range of theories and assessments commercially available, teachers are challenged to find an appropriate theory and instrument that suits their situation. Hawk (2007) reviewed six popular learning styles assessments identifying relevant criteria for each including validity and reliability. First was Kolb’s Learning Styles Inventory (LSI) (1984), based on a Dewey-like and Piagetian view that knowledge is acquired through the synthesis of experiences. The LSI
is a commercially available self-scoring instrument with reliability and validity reported by Hawk and Shah (2007) as being heavily supported by research though no statistics have been cited. The Productivity Environmental Preference Survey or PEPS was the second instrument reviewed by Hawk and Shah (2007). PEPS was developed by Dunn and Dunn (1982) as part of their Learning Styles Model which considered environmental and biological factors as influential to learning preferences. The PEPS is a 100 question self-scoring instrument that has extensive research that supports the validity of the instrument. LaMothe (1991) examined the reliability and validity constructs of PEPS among baccalaureate nursing students and found that 19 of 20 factors were confirmed as valid using Factor Analysis. Additionally, most of the subscales met minimal reliability at the .70 level established through SPSS Reliability.

Similar to the LSI, the Gregorc Style Delineator (GSD) (1988), is another self-scoring commercially available measurement. Hawk and Shah (2007), reviewed the GSD (1988), as the third instrument in their report and cited limited research as impeding the reliability and validity of the GSD although Joniak and Isaksen (1988) and O’Brien (1990) reported the GSD (1988) to be moderately reliable though only partially valid. The Index of Learning Styles (ILS) (1991) is the instrument associated with the Felder-Silverman Learning/Teaching Style Model that measures preferences in avenues of reception and processing information. According to the model’s theory, a learner’s profile emerges from preferences that are plotted along four continua representing active/reflective, sensing/intuitive, visual/verbal, and sequential/global. Like the other two measurements discussed thus far, the ILS (1991) can be self-administered and
scored. Dunn and Dunn (1982) developed The Productivity Environmental Preference Survey or PEPS as part of their Learning Styles Model that considers environmental and biological factors as influential to learning preferences. The PEPS is a 100 question self-scoring instrument that has extensive research that supports the validity of the instrument. LaMothe (1991) examined the reliability and validity constructs of PEPS among baccalaureate nursing students and found that 19 of 20 factors were confirmed as valid using Factor Analysis. Additionally, most of the subscales met minimal reliability at the .70 level established through SPSSX Reliability.

The fifth instrument discussed by Hawk (2007) was the Revised Approaches to Studying Inventory (RASI), devised by Entwistle, Hanley, and Hounsell (1995). RASI has several characteristics that separate it from those previously mentioned. RASI examines study strategies as opposed to learning preferences. According to Entwistle, Hanley, and Hounsell (1995), individual attributes for how students prefer to study and commit information to memory corresponds to knowledge acquisition within learning environments. Furthermore, there are two versions of the RASI available, a 30 question short form and a 44 question long form both of which are not able to be self-scored. Substantial research on RASI supports its reliability and validity through confirmatory factor analysis.

Among the theories and instruments reviewed by Hawk (2007) was VARK (Fleming, 2001), a model rooted in Neuro Linguistic Programming that recognizes the value of sensory strategies as highly influential to learning. VARK is not a learning style, but belongs to a category known as “instructional preferences” (Fleming, 2001). Sensory
modes, such as visual, auditory and kinesthetic learning preferences, are considered to be a single preliminary element of learning style, although learning styles comprehensively are more complex processes employing facets of cognition and personality as well. With respect to the role that it has in this study, VARK (Fleming, 2001) will be discussed in greater detail independently following Hawk and Shah’s review.

**Visual, Auditory, Read/Write, Kinesthetic Profile Questionnaire**

**Development and background.**

Unlike most learning styles assessments, VARK (Fleming, 2001) neither reports cognitive traits, nor personality characteristics as other assessments do. According to Fleming (2001), the focus of VARK is upon helping students discover personal sensory preferences which is where the name of the instrument originates, an acronym representing visual, auditory, read/write, and kinesthetic modalities. The instrument is remarkably easy to use and lends itself to self-administration as well as self-scoring both of which bolsters the validity of the results by eliminating the need for interpretation of responses by a second party.

VARK (Fleming, 2001) was conceived in response to a curiosity as to why some people struggled with map reading while others did not. Inequities observed by Fleming (2001) regarding map interpretation, urged him to suggest that some mental boundaries exist that define intellectual strengths among people. Concerns surrounding these disparities inspired an investigation into the design and the roles of prevailing instructional models for teaching geography. The basis for developing VARK (Fleming,
2001) was chiefly Bandler and Grinder’s (1979) theory of Neuro Linguistic Programming that recognized that people possess different “representational systems for understanding their environment” (Fleming, 2001 p. 43). Representational systems pointed to sensory perceptions as the key to understanding the world and prior to the advent of VARK (Fleming, 2001), sensory modality as defined by Swassing, Barbe, and Milone (1979) recognized three paths of information access as, visual, auditory, and kinesthetic.

Stimulated by an article on neuro-linguistic programming Fleming’s (2001) inquiry would eventually blossom into a more global investigation of why some students demonstrated learning in spite of poor instruction while others failed despite superior teaching. The product of this inquiry would be a questionnaire that evolved into VARK (Fleming, 2001). The initial questionnaire asked students to describe and comment on their learning environment, to which a noticeable pattern emerged expressing discomfort at some level with how information was being taught. Fleming and Mills (1992) stated that, “by questioning students, we found that many students attributed their learning difficulties to the form in which the course material was presented,” (p. 138). Responses indicated that oral or visual presentations styles were the most challenging for students, inspiring Fleming and Mills (1992) to focus their investigation on sensory modes as an instructional vehicle.

It is important to the mission of VARK (Fleming, 2001) to remember that it examines modalities, not styles and that no single profile guarantees academic success; therefore VARK (Fleming, 2001) has no correct or incorrect answers. Dunn and Dunn (1989) for example recognized 18 elements that comprise a learning style and modal
preference pertains to the singular perceptual part of their definition. Furthermore, Fleming (2001) advised that modalities may perhaps be the most compelling feature of a learning style claiming that “modal preferences are quite easy to explain to students and for them, it works” (p. 46).

Fleming noticed that in computer education classes, students expressed a definitive preference for working in an iconic operating system such as Macintosh, or the text-based DOS platform, an observation which inspired recognizing reading as a possible independent fourth modality (2001). Fleming (2001) distinguished between visual and reading as discretely perceptive, whereby icons engage image representation as opposed to the symbolic pattern decoding skills required for reading text. Parallel associations between kinesthetic and tactile/haptic modes reflected similar macro/micro relationships whereby kinesthetic mode pertained to gross movement while tactile/haptic sense pertaining to finite manual dexterity. Inadvertently the decision to acknowledge haptic sense as a fifth mode was abandoned and tactile/haptic remains incorporated into the working definition of kinesthesia.

Description of VARK questionnaire.

VARK (Fleming, 2001) is a 16 question, self-reporting instrument that deliberately uses vernacular syntax describing real life experiences to facilitate ease of use and elicit reliable responses. Despite a concerted effort to make the questions culturally neutral, Fleming (2001) acknowledges that grammar may not be culturally solvent beyond western society, thus, subjecting the instrument to possible criticisms of
cultural bias. VARK is recommended as suitable for persons over 18 years old; however, age appropriate versions for adolescents have since been developed (Fleming, 2001).

In spite of several attempts to establish statistical reliability and validity of VARK (Fleming, 2001), Svinicki’s team at the University of Texas, Austin failed to confirm it at a statistically significant level. Consequently, Leite’s (2010) work, does not support VARK (Fleming, 2001) being used as an adequate and viable research tool, however, Fleming (2001) maintained that compared against student’s self-perceptions as learners, VARK (Fleming, 2001) was very accurate, indicating strong content validity of the instrument. Berry (2010) examined the correlation of student self-opinions of personal learning style with VARK (Fleming, 2001) reported scores. According to Berry (2010), 42.9% of ninth grade students who participated in the study had VARK (Fleming, 2001) scores that matched their predicted learning preferences.

Leite (2010) remarked that the isolated nature in which learning styles instruments are developed makes them particularly vulnerable to validity issues, however, VARK (Fleming, 2001) conformed to a four-factor correlated trait–uncorrelated method (CTCU) model rendering the reliability estimates of the scores as adequate. Leite (2010) reported these findings as preliminary though, and recommended researchers to approach VARK (Fleming, 2001) cautiously as these scores fell slightly short of establishing statistical confidence with this instrument and warranting additional research to secure more solid validity. Although Leite et al. (2010) posited VARK (Fleming, 2001) as demonstrating validity and reliability commensurate with a “low-stakes diagnostic tool” (p. 336) they support its consideration for use as a research tool to
investigate instructional methods and researchers should feel comfortable using it in that capacity.

VARK’s low statistical value according to Fleming (2001) is inconsequential to its intended use as an instrument whose, “strength lies in its educational value for helping people think about their learning” (p.49). VARK is not a learning style designation in and of itself nor was it designed to quantify learning categorically as Fleming (2001) explained, “modal preferences are only one part, admittedly a powerful and pragmatic part of a complex set of attributes that make up a learning style” (p.46). Leite et al. (2010) reported that the reliability of VARK (Fleming, 2001) as a diagnostic tool is adequate and appropriate for use as an instrument to aid students in realizing their individual learning preferences.

**Criticisms of Learning Styles**

Curry (1990) identified three violations to credibility of learning styles theory. Foremost, redundant and vague terminology tends to obscure clarity and generate confusion of definitions. Second, there is insufficient support of sound validity and reliability among many assessment measures as noted by Markham (2000), who failed to locate evidence to authenticate learning styles inventories in the *Mental Measurement Yearbook* (1998). The *Mental Measurement Yearbook* (1998) is a compilation reference source containing over 2,700 instruments used in the social sciences, education and leadership. Finally Curry (1990) reported the ambiguity of stylistic traits among learners and the learning environment as problematic to ascribing validity to learning styles
theories in general.

According to Coffield (2004), the idiosyncratic and philosophical nature surrounding learning styles theories creates inherent problems with assessing them. Inconsistencies surrounding validity and reliability of some learning styles models jeopardize their credibility as convincing authoritative resources. Coffield (2004) claimed learning styles to be weak and transparent because they encourage somewhat of a shopping expedition for the best intellectual product. The British Educational Communications and Technology Agency (BECTA) surmised that learning styles theories are fallible and failed to find any evidence that support the trustworthiness of any single model as beneficial.

Researchers working in the field of learning styles across or within these disciplines tend to interpret evidence and theories in their own terms. Evidence about learning is guided by contrasting and disputed theories from psychology, sociology, education and policy studies, and is valued in different ways from different perspectives (Coffield, 2004 p.1).

According to (Markham, 2000), learning styles research has yet to yield substantial data supporting evidence of any positive influence that learning styles may have over learning. Dembo (2007) challenged the caliber of a learning styles approach accusing it to be narrow and questioning whether such a focus might be possibly inhibitive to developing holistic learners. Such instability and unreliability holds the potential to produce “at best debatable, and at worst unethical” results according to Markham (2000). Authentic measurement of any human behavior should demonstrate clear validity that can be
supported via a veritable document confirming its development and reliability (Markham, 2000). Furthermore, examining sources outside of an instrument’s targeted arena of application is prudent to bolstering its credentials and guarding against biases. Finally, Markham (2000) recommended that given the transparency of the learning styles field, prudent research should consult as many sources as possible and seek professional advice in selecting the most appropriate measure possible.

**Matching and Mismatching Teaching to Learning Styles**

Wildman (1981) noted that unsuccessful learning experiences create mutual frustration for both students and teacher. Furthermore, Beck (2001) recognized that all students do not learn alike and therefore, teachers have a responsibility to reach students via their individual intellectual strengths through experiences that are “intellectually honest” (Bruner, 1960, p.33). Intellectual honesty according to McLoughlin (1999) begins with recognizing individual learning preferences and accommodating them in ways that promote personal investment in learning. Wildman and Burton (1981) recommended that teachers design tasks with sensitivity to the technical demands of the task as well as consider the mode or “dominant process” of the learner that will assist their “progress from naiveté to competence” (p. 750).

Aligning teaching approaches with student learning strategies has been thought to be a viable option for supporting student achievement. Carroll (1963), for example, claimed that mode of presentation had as great a positive influence on student achievement as student aptitude or IQ. Ford (2001) also found that postgraduate students
whose learning preferences were met outperformed those whose styles were mismatched when challenged to design webpages. According to Willingham (2005), however, teachers should allow the content to guide the optimum delivery approach and not individual student learning styles. Jones, Reichard, and Mokhtari (2003), conducted a study that investigated association of learning styles with academic discipline to examine the rigidity or elasticity of student learning capacities within different environments. A majority of participants (81%) were found to demonstrate an ability to adapt and use multiple learning style preferences as they traversed different classes (i.e. English, Mathematics, Social Studies or Science), concurring with Willingham (2005) that learning styles is discipline specific.

**Criticisms of Matching and Mismatching Teaching to Learning Styles**

A contentious debate surrounds matching teaching styles with learning styles. For instance, Liu and Graf (2009) disputed the value of matched styles instruction citing that little evidence exists supporting that learning preferences have any influence on the performance of learners in matched or mismatched courses. Furthermore, Kampwirth and Bates (1980) reviewed 22 matching studies and found that only two demonstrated significant positive effects on achievement. Twenty of the remaining studies failed to demonstrate clear evidence that matching styles had any favorable impact on achievement over mismatched. Opponents of matched teaching contend that accommodating a single learning style is neglectful and fails to prepare students for the range of presentation modes that they are likely to encounter in the world. Hayes and
Allinson (1997) advised that exposure to mismatched learning can only be beneficial to broaden students experiences with negotiating the gamut of learning possibilities that they may encounter in the future. Loo (2004) concurred suggesting that the most prudent and profitable approach to students’ success might be to expose them to a range of learning methods rather than limit them to fewer. Liu and Graf (2009) also agreed claiming that diversity is the best approach for students to develop facility with styles outside of their comfort zone and prepare for real world experiences that may not always be able nor willing to accommodate individuality.

Matching teaching styles with learning styles has been shrouded by contentious debate for as long as learning styles have influenced classroom pedagogy. One of the chief proponent platforms for matching instructional approaches to learning styles resides in the belief that students will remain actively engaged in meaningful learning when their intellectual needs are met. For example, Felder and Silverman (1988) claimed that complementing student learning preferences with appropriate teaching styles could help avoid with students becoming disenfranchised from learning. Pashler, McDaniel, Rohrer, and Bjork (2008), recommended that in the face of weak evidence supporting learning styles approach to instruction, time and resources would be better spent pursuing other educational practices that have a more solid and sound evidence base. The crux of research devoted to examining an instructional design where teaching is matched to student learning preferences resides outside of music education and certainly distant from the scope of instrumental instruction. With the exceptions of Gillespie, 1993, Mueller, 1996, Reidlinger, 2000, Molumby, 2004, and Shepherd, 2004, few threads of
learning styles instruction have permeated instrumental music pedagogy. Therefore, it will be the twofold purpose of this study to examine such a matched approach in the hope of advancing the effectiveness of vibrato instruction as well as contribute to the existing body of learning styles literature.

**Learning Styles and Music**

Music is unique in that it is inherently multimodal and routinely engages all of the modes. Several studies in fact have examined the association between presentation modes and music learning. As a leading researcher in the field, Diane Cummings Persellin conducted a series of studies inquiring whether an association exists between modality matched instruction and music achievement. The first of these studies conducted in 1988 compared the teaching techniques of music teachers with their own perceived modality preferences and found that a positive correlation inferring that music teachers tend to teach with the comfort zone of their own personal learning preferences. In 1989, Persellin examined correlations between learning music rhythms patterns and student modality preferences among third graders. Data from the rhythmic patterns tests revealed that 41% scored best visually, 40% auditory and 19% kinesthetically, suggesting a strong correlation between a child’s modality preference and use of that modality to learn simple musical rhythmic patterns. Furthermore, Persellin (1989) observed that when learning through their dominant modality, the children learned the patterns in less time than if presented in either of the other two modes leading her to recommend mode responsive instruction as beneficial in the music classroom.
Persellin (1990) conducted a follow up study investigating the relationship between children’s recall of rhythm patterns as presented through dominant modalities of first grade, third grade, and fifth grade students. Maturation was found to positively influence subjects’ abilities to recall the patterns accurately, noting that the visual mode demonstrated the most dramatic increase which coincided with the development of visual decoding skills as children approach reading age. Furthermore Persellin (1990) suggested that younger children tended to rely more heavily on auditory and kinesthetic outputs corresponding with their lack of confidence or unfamiliarity with visual or written stimuli. Comparatively, Persellin (1990) found that none of the groups, even the fifth graders as the most mature of her subjects fared well with engaging more than two modalities at the same time, suggesting that first, multi modalism is a function of cognitive maturity, and second that the stability of modal preferences is dynamic and susceptible to change over time with age.

Two other studies by Persellin in 1990 and 1994 investigated the effect of learning modalities on pitch matching abilities among first graders and preschool children, hypothesizing age as an important determinant in the application of modality instruction. Results indicated that children who employed multimodal capacities had the greatest facility with matching pitch and rhythmic patterns as compared to those who relied solely on one mode. Likewise, Persellin (1994) found that a variety of sensory inputs greatly reduced the instructor’s time refocusing the subjects to remain on task. The greatest challenge was noted with the kinesthetic group who required the most redirection to focus and engage on the instructional activity. Persellin (1994) suggested “when only
the kinesthetic learning modality is used, to the exclusion of others, music learning may be impeded” (p. 6).

Mason (2001) examined the relationship between learning style and music reading skills among seventh grade instrumentalists to identify the role of field dependent and independent factors in music reading development. Data from this study indicated that music reading skills of seventh grade students were relatively unaffected by mode specific presentation. “Three sensory modes – visual, tactile, and kinesthetic – were found to have negative correlations with music reading achievement (V = -0.03, T = -0.15, K = -0.03)” (Mason, 2001, p. 121). Mishra (2007) also reported mixed results regarding whether or not mode specific presentation of musical tasks was advantageous to achievement citing that “learning of musical tasks may or may not be related to learning modalities and matching task presentation with dominant learning modality may or may not facilitate learning” (p.7).

Existing studies thus far have been concerned with musical cognition, such as music reading, pitch matching and expression of rhythmic patterns. Of relevance to this current research, only a few studies have approached the effect that matching teaching with individual student learning styles has on teaching instrumental music lessons. Molumby (2004) taught a course of studio flute lessons to university students through matched instruction that focused on the application of a broad range of musical devices encompassing: rhythmic integrity, phrasing, technical fluidity, and ensemble skills. Although the expression of such devices in a performance context requires technical demand of the instrument, the core of Molumby’s (2004) study was embedded in
teaching abstract nuances of interpretation as opposed to the concrete mechanics of performance technique as intended by the currently proposed study. Furthermore, as university students, participants in Molumby’s (2004) study were significantly more advanced than the intended middle school population of this study. According to Molumby (2004), however, teaching to a student’s individual learning preference has merit for empowering learners with personal connections to concepts and material and ultimately promoting achievement, suggesting that this approach may also have merit with a younger audience. To date within the scope of an exhaustive literature review, no such studies have been found that address similar issues with middle school aged instrumentalists or with string instrumentalists specifically.

Learning to play an instrument involves a level of intricacy that synthesizes visual, aural and kinesthetic skills. Often this requires a student to use judgment and make inferences that encourage the proper adjustments toward skill development. A learning styles approach to instruction supports the complexity skill development on a musical instrument by considering depths of independence of the learner. For example, cognitive style has two dimensions coinciding as either field dependent or independent. The field dependent learner relies on structure and meaning that is provided by the teacher which Ford (2001) referred to as the “spectator approach” (p. 7). In contrast, a field independent learner is adept at creating his or her own structure and making sense of experiences autonomously. Molumby (2004) cited the ensemble musician as an example of field dependence and the solo performer as demonstrating field independence.

Leveling and sharpening (Doyle, 1984), represent another association of learner
autonomy analogous to field dependence and independence in that levelers devise meaning in context of previous experiences that serve as structural lexicons. As a result, the leveler needs to rely on more past experiences in order to categorize new information. Sharpeners by contrast are adept at realizing context in the moment and independent of previous experience. The sharpener relies minimally on prior memory, and thus is adept with constructing meaning independently (Doyle, 1984).
Chapter III

Methodology

Traditionally, public school string instruction recognizes the differences between the violin, viola, cello and double bass as defining characteristics that guides instruction and organization of lesson groups for beginning strings. Such a design is intended to facilitate teaching and support unified instruction by minimizing interference that may result from the relatively minor differences among the instruments. This study offered an alternative to the traditional instructional approach by supplanting instrument type with dominant learning modality as the defining criteria for assembling lesson groups. Within such a structure, group assignments were made to consciously honor student learning preference categories as visual, auditory or kinesthetic learners rather than instrument type.

This study followed a quantitative, quasi-experimental research design. Four groups were created, three experimental groups, corresponding to visual, auditory and kinesthetic learning modalities, and one control group, mirroring the diversity of mixed instrumentation and learning styles found in a traditional class setting. Each of the three experimental groups was taught via presentations that accommodated participants’ learning preferences such as visual, auditory, or kinesthetic. Conversely, the control group was taught through a traditional approach using *Viva Vibrato* (Fischbach, 1998), an instructional method text designed specifically to target vibrato development within a heterogeneous class environment. One of the limitations of this design as opposed to random assignment was that the population size was not able to be controlled to yield an
equally balanced population within each group. As a result, group sizes ranged from 20 being the largest, to eight as the smallest.

This study spanned eight weeks. The first two weeks involved administering VARK (Fleming, 2001) to identify dominant learning preferences of all participants and a recorded pretest to evaluate existing vibrato skill. The third week began the six week intervention period of pull out vibrato lessons outlined in Appendix A. Procedures describing the process will be explained later in this chapter. Following the intervention, posttest recordings were made as an exit assessment. All recordings were evaluated by a qualified panel of string educators.

Participants

Demography.

Participants in this study were drawn from the roster of 6th, 7th and 8th grade students enrolled in the string orchestra class at a middle school in northern New England whose population is 1,014 students, with mild ethnic diversity. The majority of students are Caucasian non-Hispanic (88%), with 5% representing Asian/Pacific Islander, and 5% African American. Only two percent of students are Hispanic and less than one percent is Native American or Native Alaskan. Furthermore, twenty-nine percent of the total student body participates in a district subsidized lunch program, thus qualifying them for loan of school owned instruments free of charge as opposed to exercising other options such as renting or providing a personally owned instrument.
Procedure

Prior to commencing the study, the researcher obtained appropriate levels of permission to conduct the proposed research, from school district administration, parents of participants, and the Boston University Institutional Review Board. In addition, to maintain privacy of participants each student was assigned a unique reference number as an identification substitute in lieu of names (see Appendix A). Reference numbers were used throughout the duration of the study to anonymously collate and report data as it related to individual participants.

Pretest.

All participants were first administered VARK (Fleming, 2001) as a means of identifying their individual dominant learning modality profiles. VARK (Fleming, 2001) questionnaires were administered and self-scored by students, as per the instructions in the test manual, and scores subsequently rechecked by the researcher to insure accuracy of the scoring as reported by the participants. Individual VARK (Fleming, 2001) scores were then recorded as an essential level of data on the participant roster (see Appendices C, D and E).

Subsequently, in order to determine a baseline against which to measure progress, preexisting vibrato skill was evaluated using a performance based pretest in which students were asked to play a researcher designed 17 measure Canon in D (Pachelbel) excerpt using vibrato. The excerpt followed the opening melodic pattern of Canon in D (Pachelbel) using only whole notes and was performed at a tempo of 60 beats per minute.
as to allow ample opportunity for the participants to express vibrato throughout the passage. Furthermore, pretest performances were recorded using a Zoom H2 handheld digital recorder and audio files were archived on to compact disc via a laptop computer. Recordings were then submitted to a three-member panel of qualified and highly experienced string educators for evaluation using Gillespie’s (1993) vibrato evaluation instrument that assesses five characteristics of vibrato quality, width, speed, evenness, pitch stability, and overall sound quality. Inter-rater agreement of the scores was computed using simple percentage formulae to determine reliability of judges’ responses.

Although no reliability data has been published regarding Gillespie’s (1993) instrument, the rating form has been a popular choice for evaluating vibrato quality and has been employed in several previous studies including, Gillespie (1993), Mueller (1996), Gillespie (1997), and Shepherd (2004). In each of the five evaluative categories performances are subjected to being rated using a five point Likert-type scale, 5 corresponding to the strongest or most mature skill and 1 representing the weakest or most novice skill. A student who achieved a cumulative score of 19 or below on the vibrato pretest was identified as a suitable candidate to participate in this study since the study was concerned with a population for whom vibrato is a novice skill. A composite score of 19 or less was considered by the researcher to represent developing vibrato based on the rating scale employed in the vibrato evaluation instrument where a score of four in any single category was indicative of “better than average” skill. Therefore, achieving a four in all five categories would yield a composite score of 20, representing above average vibrato ability. Subsequently, those students who scored 20 or greater were
excused from the study and their data was omitted from the study. Performance scores collected from this pretest were archived for use as baseline data representing preliminary vibrato skill and were recalled at the conclusion of the study for comparison against post-test data to assess the effectiveness of the treatment.

**Participant group definitions.**

*Control group.*

Following the identification of dominant learning preferences using VARK (Fleming, 2001) the control group was created by assembling all participants who were identified as having read/write strength. Students possessing read/write preferences were considered suitable for the control group based on the text based method that they would be taught using a traditional class method book. In order to stabilize the sample sizes equitably, members from the two larger groups of visual and kinesthetic learners were arbitrarily chosen to join the control group and balance the group sizes.

*Experimental groups.*

Data collected from VARK (Fleming, 2001) were employed to assign the remaining students to one of three experimental groups that corresponded to individual identified learning preferences in preparation for intervention. Three experimental groups were created representing visual, auditory and kinesthetic learner preferences. In contrast to the control group, experimental groups comprised of students who shared characteristics of similar dominant learning modality within a population of mixed instrumentation. The basis for organizing the experimental groups in this manner rested
upon this study’s hypothesis that presentation mode may have a more profound influence on student learning than favoring instrument type as a defining criteria for instruction. Furthermore, no specific instructional modifications were made to address individual differences between violins, violas, cellos and double basses in each of the experimental groups.

**Intervention.**

Intervention for this study began in the second week of the study and continued over the duration of six weeks. Each of the four groups received one 30- minute lesson that met according to a rotating schedule appearing in Appendices B and C. Lessons scheduled during the school day coincided with their scheduled orchestra class and participants were excused from their regular orchestra class to participate. The structure of the building master schedule, however, prohibited combining all three grade levels at once so that they can be taught simultaneously, therefore, lessons were repeated three times daily for grades, six, seven and eight.

In addition, all three experimental groups and the control group were scheduled for six 30-minute supplemental lessons per week which met and was taught after school. Instructional methods used for each group in the supplemental lessons mirrored those used during the school day. Because the after school schedule did not impose the same restrictions as the daytime building schedule, students in all three grades (i.e., 6, 7, and 8), were able to be taught simultaneously within each of the three experimental groups as well as the control group. Based on the intervention lesson schedule, all participants
ideally would have received a total of 12 lessons equaling 360 minutes of instruction as a result of participating in both the in school and after school lessons.

Since the groups were heterogeneously mixed by instrument, all three experimental as well as the control group were as previously noted, taught following the curriculum outlined in a popular vibrato method book, *Viva Vibrato* (Fischbach, 1998) as a primary teaching resource. This text is divided into five stages that correspond to the sequential development of the ranges of motion associated with vibrato performance as advocated by Fischbach (1998): vibrato readiness (stage I); the birth of vibrato (stage II); the developing vibrato (stage III); the maturing vibrato (stage IV); and the artistic vibrato (stage V). Each instructional stage presented in *Viva Vibrato* (Fischbach, 1998), involves a balance of unique exercises called “Swingercises,” that are designed to develop fundamental motor skills associated with vibrato development. Additionally, musical passages are provided to accompany the “Swingercises” in which students, may practice and cultivate the motions into vibrato.

Vibrato readiness (stage I) is a preparatory phase during which participants explore gross motor concepts that will eventually be cultivated into vibrato. Each “Swingercise” practiced during this stage is designed to rehearse key mechanisms of vibrato motion and help the student develop tension free movement before approaching the fingerboard of the instrument. “Swingercises” in subsequent stages following vibrato readiness; become progressively more refined as skill develops and vibrato begins to emerge. In order to accomplish the intervention within the allotted time frame of six weeks, participants progressed sequentially through only the first three stages of vibrato
development presented in *Viva Vibrato* (Fischbach, 1998), vibrato readiness, the birth of vibrato, and developing vibrato in two week intervals and appropriate modifications were made in order to adapt each stage to meet the learning preferences of each experimental group. Learning style modifications to the “Swingercises” are described sequentially in detail in the research diary appearing in Appendix D.

The following section describes the Swingercises that were employed by each participant experimental and control groups in this study. Swingercise #3 entitled “Shake, Rattle, and Roll,” develops fluid range of motion that contributes to controlling the rate and extent of a vibrato oscillation. The exercise simulates vibrato motion by rocking the forearm back and forth while maintaining a “rubbery” wrist joint that allows the hand to flex with freedom. Swingercise #4, “Palmpats” engages the students in transferring the motion learned in Swingercise #3, to the instrument. To perform a “Palmpat,” violin students in the control group will place their thumbs at the base of the neck while holding the violin in playing position. The remaining fingers will be collapsed over the upper bout of the instrument in a curved fashion as to allow the fingertips to freely tap the bout in rhythmic patterns prescribed by the text.

Swingercise #6A entitled “String Polishing” is another exercise that rehearses movement on the instrument by simulating an exaggerated motion used to control vibrato extent by polishing along the length of the string. To encourage smooth and fluid motion this exercise will be done in banjo position where the instrument will be cradled under the right arm instead of being traditional playing position. The companion exercise for Swingercise #6A will be Swingercise #10, “Stringsine,” which repeats the process only
this time holding the instrument in playing position and securing the thumb in third position. Practicing this exercise in third position allows ample room for the students to obtain the proper oscillation width while the thumb remains stationary.

Differences between experimental and control groups resided in the modes of presentation. The control group was taught employing the print versions of *Viva Vibrato* (1998), and followed the progression of the text as is commonly practiced in classroom string classes. However, accommodations were made for the experimental groups to facilitate matching instruction with each group’s preferred learning modality. Intervention for the visual and auditory groups, for example, incorporated the *Art of Vibrato* (Fishbach, 2004) DVD, video companion to *Viva Vibrato* (Fischbach, 1998) as the primary instructional source. In order to create an exclusively visual or auditory learning environment, the video imagery of the DVD was isolated by silencing the audio track during visual group lessons. Likewise, only the audio track absent of imagery was presented to the audio group to isolate a purely auditory experience. Only portions of the DVD corresponding to the set of “Swingercises” presented via text to the control group were presented to ensure that all groups are receiving identical instruction.

Creating a genuine kinesthetic teaching environment required additional creative modifications to the instructional method to carefully eliminate any residual influences from visual and auditory stimuli. Therefore, each of the four “Swingercises” was modeled through activities simulating the desired outcome vibrato motion. Furthermore, each activity was associated with a brief cue to describe and prompt the intended range of motion to be rehearsed. Cues were used in lieu of teacher modeling or lecture description.
to disguise the modeled activity and guard the integrity of the lesson from contamination of the other sensory stimuli. A detailed explanation of kinesthetic modifications appears in the research diary in Appendix B.

**Posttest and data analysis.**

Following the interventions as described above, all groups participated in a posttest assessment to determine the effect of the independent variable (learning modality instruction) upon the dependent variable (measure of vibrato performance skills). Materials and procedures for the posttest replicated those which were previously used in the pretest including the *Canon in D* (Pachelbel) excerpt. Conditions for administering and evaluating the posttest, (i.e., tempo, recording apparatus, and evaluation process) also replicated what had been introduced during the pretest to guard validity. Mean scores were computed for individual participants using scores reported on the pretest and posttest. In addition, a means of difference was computed to reflect the change in scores between pretest and posttest. Three sets of data corresponding to the pretest means, posttest means, and means of differences were analyzed descriptively using measures of central tendency and frequency distributions. The null hypothesis was tested using a Kruskal-Wallis $H$ test.
Chapter 4

Results

The effect that teaching to specific learning modalities had on vibrato development was examined using data collected from pretest and posttest recordings of all the participants. These recordings were submitted to a panel of judges who were instructed to evaluate them using Gillespie’s vibrato evaluation instrument (Gillespie, 1993). Judges evaluated width, speed, evenness, pitch stability, and overall vibrato quality using a five point Likert scale to rate skill levels within each item category. A composite score was then tabulated for each participant representing the sum of the item category scores. Three datasets corresponding to pretest means, posttest means, and means of difference were computed from composite scores reported by the judges. Descriptive statistics were reported for comparisons between grades, sexes, and instrument types, and a Kruskal-Wallis H test was conducted to determine differences among learning preference groups.

Design

Differences between four groups, (three experimental groups and one control group), were examined. The nature this study prohibited random assignment of the participants among the groups therefore rendering a quasi-experimental design as most suitable. The null hypothesis was tested using a Kruskal–Wallis H test and descriptive statistics were reported on three characteristics of the independent variable to address the research questions pertaining to grade, gender and instrument. In three of the four
analyses, (e.g., learning styles, gender and instrument), data represented the combination of participants across grades six, seven, and eight. Only the gender analysis was parsed by grade level. Furthermore, three datasets were created for each analysis corresponding to, means of pretest, means of posttest and means of difference between pre and posttests, computed from composite scores reported by judges using Gillespie’s vibrato evaluation instrument (Gillespie 1993). In all further discussions of analysis, “dataset” will refer to the group or groups of scores (pretest, posttest, or means of difference) being analyzed. Reliability of Gillespie’s vibrato evaluation instrument was also computed using Cronbach’s Alpha, and inter-rater agreement was determined employing simple percentile computations. The reader is reminded to interpret the results reported with caution to the risk of Type I and Type II errors that may have occurred as a result of irregularities of sample size and normality of distribution.

**Inter-rater Agreement and Reliability of Gillespie’s Vibrato Evaluation Instrument**

The judge’s panel consisted of three veteran string educators from New Hampshire. All three judges were violinists who are seasoned music educators, each having 30 or more years teaching experience in public and private schools. Additionally, all three judges have extensive experience teaching at the middle and high school levels, therefore making them qualified to evaluate musical performances of this age group. Two levels of inter-rater agreement were computed for both the pretest and posttest scores using a simple percentile formula demonstrating the percentage of when all three judges agreed, and the percentage of times when at least two of the three judges agreed.
In each case, sums of agreed items were divided by 300, the total number of possible responses, (5 items X 60 subjects). Scores for all three judges coincided 22% of the time on the pretest and 20.6% of the time on the posttest. Scores computed for two-way agreement between judges however revealed a more significant level of consensus yielding 83.6% on the pretest and 89.6% on the posttest.

Cronbach’s Alpha for Gillespie’s vibrato evaluation instrument (Gillespie, 1993), was found to be .888, exceeding the standard .700 level of confidence for reliability commonly employed in social sciences. Notably, score ranges for all items were within 1 point of one another with the exception of item 4 (pitch stability) which demonstrated the greatest dispersion of range (+/- 3). Cronbach’s Alpha for each item of Gillespie’s vibrato evaluation instrument (Gillespie, 1993), are reported in Table 1.

Table 1

*Cronbach's Alpha for Variables examined by Gillespie's Vibrato Evaluation Instrument*

<table>
<thead>
<tr>
<th>Variable measured by Gillespie’s Vibrato Evaluation Instrument</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibrato width</td>
<td>.838</td>
</tr>
<tr>
<td>Vibrato speed</td>
<td>.836</td>
</tr>
<tr>
<td>Vibrato regularity</td>
<td>.836</td>
</tr>
<tr>
<td>Pitch Stability</td>
<td>.973</td>
</tr>
<tr>
<td>Overall vibrato quality</td>
<td>.837</td>
</tr>
</tbody>
</table>
Results of inter-rater agreement computations and Cronbach’s Alpha suggest that the data collected using Gillespie’s vibrato evaluation instrument (Gillespie, 1993), has stable validity and reliability.

**Descriptive Statistics**

**Characteristics of the sample.**

Sixty students who were enrolled in their school orchestra program at a northern New England middle school participated in this study. Fourteen participants were in the eighth grade, 26 were in the seventh grade, and 20 were in grade six. Sixteen of the sixty participants were boys, and 44 were girls. Of the 60 enrolled, 36 participants played the violin, seven played the viola, 16 played the cello, and one played the double bass.

Learning preferences were identified for all sixty participants using VARK (Fleming, 2001) and four groups were formed representing three learning preferences corresponding to visual (N = 17), auditory (N = 8), and kinesthetic (N = 20), in addition to one control group (N = 15). Characteristics of the sample (e.g., grade level, gender and instrument), are described in Tables 2, 3 and 4, showing the number of students within each category sorted by the characteristics that defined them.
Table 2

*Characteristics of the Sample sorted by Grade level*

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>Boys</th>
<th>Girls</th>
<th>Violin</th>
<th>Viola</th>
<th>Cello</th>
<th>Bass</th>
<th>V</th>
<th>A</th>
<th>K</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>20</td>
<td>4</td>
<td>16</td>
<td>12</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>26</td>
<td>5</td>
<td>21</td>
<td>16</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>8</td>
<td>2</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>14</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 3

*Characteristics of the Sample sorted between Sexes*

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Violin</th>
<th>Viola</th>
<th>Cello</th>
<th>Bass</th>
<th>V</th>
<th>A</th>
<th>K</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>16</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Girls</td>
<td>44</td>
<td>16</td>
<td>21</td>
<td>7</td>
<td>29</td>
<td>4</td>
<td>11</td>
<td>0</td>
<td>10</td>
<td>5</td>
<td>16</td>
<td>13</td>
</tr>
</tbody>
</table>
Table 4

*Characteristics of the Sample sorted by Instrument*

<table>
<thead>
<tr>
<th>Instrument</th>
<th>N</th>
<th>Boys</th>
<th>Girls</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>V</th>
<th>A</th>
<th>K</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violin</td>
<td>36</td>
<td>7</td>
<td>29</td>
<td>12</td>
<td>16</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Viola</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Cello</td>
<td>16</td>
<td>5</td>
<td>11</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Bass</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Additionally, Table 5 represents the distribution of the sample by learning preference based on VARK (Fleming, 2001) results.

Table 5

*Distribution of the Sample based on VARK Results (N = 60)*

<table>
<thead>
<tr>
<th>Learning Preference</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>17</td>
</tr>
<tr>
<td>Auditory</td>
<td>8</td>
</tr>
<tr>
<td>Read/Write</td>
<td>15</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>20</td>
</tr>
</tbody>
</table>

Participants who demonstrated read/write preference were assigned to the control group based on the rationale that they would have access to text based method books for their
lessons. Comparisons of datasets were also reported for each of the independent variable characteristics identified by the research questions. These comparisons are described in the following section with their accompanying tables and figures.

**Research Question 1**

*What differences exist, if any, with vibrato acquisition on string instruments among students in grades six, seven, and eight when teaching is matched to individual learning preferences?*

Three instances of means of central tendency were computed for grades eight (N=14), seven (N=26), and six (N=20) corresponding to three datasets and appear in Table 6.

**Table 6**

*Pretest, Posttest and Means of Difference among Grades 6, 7, and 8*

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>Pretest Mean</th>
<th>SD</th>
<th>Posttest Mean</th>
<th>SD</th>
<th>Means of Differences</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>20</td>
<td>8.57</td>
<td>1.80</td>
<td>10.88</td>
<td>2.49</td>
<td>2.50</td>
<td>2.18</td>
</tr>
<tr>
<td>7</td>
<td>26</td>
<td>8.90</td>
<td>3.23</td>
<td>13.08</td>
<td>3.26</td>
<td>4.14</td>
<td>3.04</td>
</tr>
<tr>
<td>8</td>
<td>14</td>
<td>10.57</td>
<td>4.26</td>
<td>14.40</td>
<td>3.78</td>
<td>3.89</td>
<td>2.95</td>
</tr>
</tbody>
</table>

Contrary to what one might assume regarding correlations between age, experience and progress, observations from Table 6 reveal that the greatest increase between pre and posttests occurred among seventh graders rather than eighth as noted by the means of
differences. The stacked bar graphs represented in figures 1, 2, and 3, illustrate learning style mean score distributions, depicting how individuals performed in all three datasets.

Figure 1. Distributions of pretest mean scores among grade levels. Count represents the number of students who achieved each score, (N = 60).
Figure 2. Distributions of posttest mean scores among grade levels. Count represents the number of students who achieved each score, \(N = 60\).
Figure 3. Distribution of means of difference scores among grade levels. Count represents the number of students who achieved each score, (N = 60).

Distribution of pretest scores appeared to be more fragmented than posttest implying that although not statistically significant the intervention lessons did influence progress with learning vibrato especially among the seventh and eighth grades. In addition, seventh graders demonstrated the most consistent progress in skill development as noted by the shift from left (low mean scores) to center (higher mean scores) in both the posttest and means of difference. Implications of this will be addressed in Chapter 5.
Research Question 2

What differences exist, if any, with vibrato acquisition on string instruments between boys and girls when teaching is matched to individual learning preferences?

Of the three sub categories analyzed, sex groups represented the most disproportionate distribution of subjects whereby boys (N= 16), were far outnumbered by girls (N=44) nearly three to one. Measures of central tendency were computed on all three datasets, between sexes among genders and are reported in Table 7.

Table 7

<table>
<thead>
<tr>
<th>Gender</th>
<th>Pretest Means</th>
<th>SD</th>
<th>Posttest Means</th>
<th>SD</th>
<th>Means of Difference</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>11.04</td>
<td>3.59</td>
<td>14.23</td>
<td>4.24</td>
<td>4.04</td>
<td>2.68</td>
</tr>
<tr>
<td>Girls</td>
<td>8.50</td>
<td>2.79</td>
<td>12.15</td>
<td>2.80</td>
<td>4.35</td>
<td>2.68</td>
</tr>
</tbody>
</table>

Means of difference expressed the least contrast between boys and girls, suggesting that despite the diversity of scores, differences in performance trends between sexes were virtually negligible. The stacked bar graphs represented in figures 4, 5, and 6, illustrate gender mean score distributions, depicting how individuals performed in all three datasets.
Figure 4. Distributions of pretest mean scores between sexes. Count represents the number of students who achieved each score, (N = 60).
Figure 5. Distributions of posttest mean scores between sexes. Count represents the number of students who achieved each score, (N = 60).
Initially, boys appeared to slightly outperform girls on the pretest however, posttest means for both sexes clustered inward toward the median (12.01) for this dataset. Distribution of means of differences between boys and girls were similar however girls clearly progressed more than boys. Performance trends by sex should be interpreted with caution however, as some of the results represented may have been skewed by the abnormality of sample sizes.
Research Question 3

What differences exist, if any, with vibrato acquisition on string instruments among instruments (e.g., violin, viola, cello, and double bass) when teaching is matched to individual learning preferences?

The third characteristic examined was instrument, involving the creation of four groups for this analysis, corresponding to violin (N = 37), viola (N = 7), cello (N = 16), and double bass (N = 1). Preliminary measures of central tendency by instrument are represented in Table 8. Note however that the lack of multiple subjects in the double bass group prohibited the computation of a meaningful measure of central tendency rendering only raw data available for the double bass. Double bass raw data therefore were omitted from Table 8, but included with other samples of raw data reported in figures 7, 8, and 9.

Table 8

Pretest, Posttest and Means of Difference among Instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>N</th>
<th>Pretest Mean</th>
<th>SD</th>
<th>Posttest Mean</th>
<th>SD</th>
<th>Means of Differences</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violin</td>
<td>37</td>
<td>9.60</td>
<td>2.91</td>
<td>12.94</td>
<td>3.28</td>
<td>3.16</td>
<td>3.07</td>
</tr>
<tr>
<td>Viola</td>
<td>7</td>
<td>8.00</td>
<td>3.40</td>
<td>11.14</td>
<td>4.39</td>
<td>3.61</td>
<td>2.95</td>
</tr>
<tr>
<td>Cello</td>
<td>16</td>
<td>8.58</td>
<td>3.00</td>
<td>12.40</td>
<td>5.00</td>
<td>4.28</td>
<td>1.91</td>
</tr>
<tr>
<td>Bass*</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* No measures of central tendency were reported for double bass as explained above
Ranges of means within datasets were not particularly wide however cellists appeared to demonstrate the most substantial growth from pre to posttest as indicated by the means of difference. The stacked bar graphs represented in figures 7, 8, and 9, illustrate instrument mean score distributions, depicting how individuals performed in all three datasets.

*Figure 7.* Distributions of pretest mean scores by instrument. Count represents the number of students who achieved each score, (N = 60).
Figure 8. Distributions of posttest mean scores by instrument. Count represents the number of students who achieved each score, (N = 60).
Figure 9. Distribution of means of difference scores by instrument. Count represents the number of students who achieved each score, (N = 60).

Progress can be observed among violinists from pretest to posttest where scores gravitated toward the median (12.1). Means of differences indicated however that nearly as many cellists as violinists achieved scores higher than the median (3.31) indicating more consistent development among cellists, than any other instrument. Once again though, this implication should be interpreted with caution regarding the sample sizes where twice as many violinists (N = 36) participated compared to cellists (N = 16).
Research Question 4

*To what extent does matching teaching to individual learning preferences affect progress with learning vibrato on a string instrument among middle school students?*

This final research question bore perhaps the most weight of being central to the purpose of this research and therefore warranted more extensive examination employing descriptive statistics as well as Kruskal – Wallis $H$ analysis to test the null hypothesis. Measures of central tendency for learning preference groups and the control group appear in table 9.

**Table 9**

*Pretest, Posttest and Means of Difference among Learning Preference Groups*

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest Mean</th>
<th>SD</th>
<th>Posttest Mean</th>
<th>SD</th>
<th>Means of Differences</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>17</td>
<td>9.49</td>
<td>2.75</td>
<td>13.88</td>
<td>4.11</td>
<td>3.75</td>
<td>2.51</td>
</tr>
<tr>
<td>Auditory</td>
<td>8</td>
<td>10.83</td>
<td>4.10</td>
<td>14.50</td>
<td>3.69</td>
<td>3.29</td>
<td>1.14</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>20</td>
<td>9.00</td>
<td>3.27</td>
<td>12.20</td>
<td>2.81</td>
<td>3.11</td>
<td>3.27</td>
</tr>
<tr>
<td>Control</td>
<td>15</td>
<td>8.74</td>
<td>3.13</td>
<td>12.35</td>
<td>3.02</td>
<td>3.97</td>
<td>3.22</td>
</tr>
</tbody>
</table>

Despite that the control group demonstrated the greatest progress between pre and posttest, comparisons of means indicated negligible differences between each of the groups within individual datasets. Ranking the means of differences resulted in the following order, control (3.97), visual (3.75), auditory (3.29), and finally kinesthetic
(3.11) whereby the distribution of scores by proximity appeared clustered in pairs rather than distributed evenly. Differences between control and visual (.22), and between auditory and kinesthetic (.18) were similar however the difference between the middle two ranks, (visual and auditory) was .46, more than twice the value observed between either of the other pairs.

**Analysis**

The null hypothesis was tested using a Kruskal-Wallis $H$ test. The Kruskal–Wallis $H$ test is a non-parametric one way analysis of variance by ranks as opposed to means or medians to determine if any genuine differences exist between the distributions among groups. It was employed in this study as an appropriate substitute for a One Way ANOVA since the sample size and distribution violated assumptions of the ANOVA. Furthermore, according to Siegel (1956), the Kruskal–Wallis $H$ test retains 95.5% of the efficiency of the most powerful parametric F tests. Output data from Kruskal-Wallis analysis using SPSS 22.0 (2013) yielded an $H$ statistic and mean rank for each dataset. Mean rank scores reported from Kruskal-Wallis appear in Table 10 and $H$ statistics for each dataset appear in Table 11.
Table 10

Mean Ranks for Pretest, Posttest and Means of Difference by Learning Preference Group

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Means of Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>17</td>
<td>29.32</td>
<td>28.71</td>
<td>31.97</td>
</tr>
<tr>
<td>Auditory</td>
<td>8</td>
<td>37.56</td>
<td>39.00</td>
<td>28.75</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>20</td>
<td>29.28</td>
<td>27.98</td>
<td>28.60</td>
</tr>
<tr>
<td>Control</td>
<td>15</td>
<td>29.70</td>
<td>31.37</td>
<td>32.30</td>
</tr>
</tbody>
</table>

Table 11

Kruskal-Wallis H for Pretest, Posttest and Means of Difference (n = 60)

<table>
<thead>
<tr>
<th>Dataset</th>
<th>H</th>
<th>df</th>
<th>p &lt; .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest Means</td>
<td>1.52</td>
<td>3</td>
<td>.677</td>
</tr>
<tr>
<td>Posttest Means</td>
<td>2.53</td>
<td>3</td>
<td>.469</td>
</tr>
<tr>
<td>Means of Difference</td>
<td>.599</td>
<td>3</td>
<td>.897</td>
</tr>
</tbody>
</table>

The null hypothesis stated that no significant differences will occur between student groups who are taught traditionally and those whose learning preferences are matched with an accommodating teaching style. In all cases, failure to meet critical values for $H$ at the .05 confidence level compelled accepting the null hypothesis since no significant differences in the distributions were found.

Three datasets were analyzed representing pretest means, posttest means and a means of difference for four groups of variables corresponding to grade, sex, instrument, and learning preference. Based on a Kruskal – Wallis $H$ test, no significant differences
were found among distributions of learning preference groups compelling that the null hypothesis be accepted. Measures of central tendency and frequency distributions for each variable indicated that mean scores for datasets were positively influenced by the intervention vibrato lessons however no evidence was found that any of the changes in scores were a result of matching teaching approaches with grouped learning styles.
Chapter 5

Summary of Study, Conclusion and Recommendations

Summary of Study

Vibrato has been recognized as one of the least consistently addressed topics string programs due its difficulty to teach (Stewart, 1933, Kotchenruther, 1998, Wisniewski & Mueller, 1998, Shepherd, 2004, MacLeod, 2008). Primrose (1976) even admitted that he was unaware of any single method to effectively teach it. According to Bell (2007) insecurities with teaching vibrato may stem from a lack of tutorial vibrato studies available as resources to string teachers. The uniqueness of vibrato as a skill deserves instruction that is equally unique and accommodates the instrument, the student and the nuances of the ornament (Primrose, 1976). Campbell (2008) proposed learning modality as a viable approach to accommodating the individuality of student learning and Lemire (1996) recognized a sensory approach as suitable specifically for addressing music instruction. Previous studies by Gillespie (1997), Molumby (2004), Shepherd (2004), and MacLeod (2008) have investigated the influence of sensory teaching approaches on music learning. The purpose of this study therefore, was to investigate the effectiveness of matching teaching approach with student learning modality preferences in order to teach middle school orchestra students string vibrato and contribute to the one of the least researched topics in string education.

The dominant learning preferences of sixty middle school string players were identified using VARK (Fleming, 2001), upon which they were assigned as members of one of three learning modality based experimental groups (e.g. visual, auditory, or
kinesthetic), or the control group. Pretest recordings of each participant’s existent vibrato skill were made and submitted to a panel of judges for evaluation using Gillespie’s (1993) vibrato evaluation instrument. Gillespie’s (1993) vibrato evaluation instrument is described in detail in Chapter Three. Following the pretest, all groups received 12, 30 minute intervention lessons over the course of six weeks, whereupon the teaching methods were matched to accommodate each group’s learning preferences and the control group was taught using a traditional class method book. Modifications to accommodate each group’s learning preference are described in the research diary section appearing in Appendix B. At the conclusion of the intervention, posttest recordings were completed recycling the pretest material and recordings were evaluated by the judges.

Diagnostic vibrato studies such as Timmers and Desain (2000), Geringer and Allen (2004), Verfaille, Guastuvano, and Depalle (2005) focused on behavioral characteristics of acoustic vibrato properties identified by Seashore (1931) (e.g. rate, width, and shape). Although these were included as items on Gillespie’s Vibrato Evaluation instrument (1993), they were not isolated in the pedagogical context of this study. Data collected was based on the composite score derived from Gillespie’s Vibrato Evaluation instrument (1993) and three datasets corresponding to pretest means, posttest means and means of difference were computed for each participant. Analyses of the data included testing the null hypothesis using a Kruskal – Wallis H test as well as descriptive statistics for three variables, (e.g., grade, sex, and instrument) employing measures of central tendency and frequency distributions.
The null hypothesis for this study stated that no significant differences would be found between groups whose dominant learning preferences were accommodated, and those who were not. Kruskal-Wallis $H$ analysis failed to meet critical values at a statistically significant level compelling the acceptance of the null hypothesis that there were no differences between the groups.

Results from this study support those of Gillespie (1997) and Shepherd (2004) regarding the advantage of using visual modeling. Comparison of means of difference scores in the current study between the control and visual groups revealed that the visual group demonstrated the most progress among the learning preference groups. Considering that the sample sizes were similar, one possible explanation for the difference in scores between the visual and control groups could reside in the isolation of visual stimuli absent of audio. Gillespie (1997) compared audio/visual with audio alone, and Shepherd (2004) made no distinction as to whether videotapes in her study included or excluded an audio track. It was the intention of this study to isolate sensory components of instruction however future investigation could test this theory.

All learning preference groups and the control group demonstrated progress from pretest to posttest according to descriptive statistics however according Kruskal-Wallis $H$ mean ranks indicated regression in ranks between the tests for the visual and kinesthetic groups, however not to a statistically significant level. Measures of central tendency for the supplemental variables agreed with the descriptive statistics computed for the learning styles groups demonstrating consistent progress between pretest and posttest. Means of differences and Kruskal-Wallis $H$ mean ranks for learning style groups
clustered in pairs resembling a close proximity in score between control and visual groups as one pair and auditory and kinesthetic groups as the other. The difference between means of difference mean ranks for control and visual was .33, as opposed to .15 between auditory and kinesthetic, however the gap observed between visual and auditory, the second and third groups in rank order was 3.22. The implication of the visual group scoring so closely to the highest performing group in the study concurs with the value of visual media instruction as suggested by Gillespie (1997) and Shepherd (2004), an endorsement supported by trends among method book publishers to include DVD supplements to their texts.

Although not of primary concern to the core purpose of this study, it could be helpful to consider some residual observations by the researcher when interpreting these results. Dunn and Dunn (1984) recognized 20 biological factors that influence learning style including time, temperature, motivation, peer interaction and impulsiveness. Undoubtedly, unique personality trait for each group resembling Pask’s (1976) serialist and holist learner theory emerged during the intervention period. According to Pask (1976), a serialist approaches a task sequentially, in an ordered fashion where as a holist explores the task, filling in the concepts until the “whole” picture is completed. The serialist can be considered to represent patience and attention to detail while the holist embraces discovery learning. Visual learners in this study were the most sedate and attentive of all groups resembling Pask’s (1976) serialists. Although they did interact and comment occasionally on the video, their focus was the most centered. This was in stark contrast to the kinesthetic group who were the most energetic, least focused and
consequently least productive, as indicated by its fourth place standing among the means of ranks. This comparison does not imply that holists as defined by Pask (1976) are unproductive learners, but just polar opposites. Auditory learners tended to be relatively focused although somewhat impatient. Admittedly though, patience is not a strength of middle school age students. The control group was reasonably focused within the boundaries of typical adolescent and pre-adolescent behavior. The control group placed students in a traditional educational environment with which they are accustomed, without having to negotiate alternative approaches to learning. The majority of instructional time was spent on task with few instances of some students paging ahead in anticipation of the next exercise. One speculation regarding the patience and attention of visual and auditory learners could be that the instructional media vis-à-vis, video and audio tracks were not in their control as it had been with the other two groups who had physical contact with learning aids and books.

Descriptive statistics were computed for three variables corresponding to grade, sex and instrument to examine associations and patterns not identified by the Kruskal-Wallis $H$ test. Analyses of gender groups revealed nearly identical performances between them. Despite producing the most dramatically disproportionate sample sizes where girls ($N = 44$) outnumbered boys ($N=16$) nearly three to one, the difference between means of difference scores of boys and girls was virtually negligible.

Kolb (1984) suggested that experience is related to the formation of ideas and problem solving skills thus, it would be reasonable to expect that the most experienced or eldest students should have demonstrated the most progress. Descriptive statistics for
grade levels however indicated that the most progress was made by seventh grade students rather than eighth. This could be the result of several factors among which is motivation, although this study produced no evidence to support this assumption. Sixth grade students by contrast demonstrated the weakest performance across all three datasets inferring that students that young may not yet possess adequate motor or cognitive abilities to approach a skill as complex as vibrato. Performance trends depicted in this study do infer however that seventh grade may be a more appropriate age to introduce vibrato in a class environment, although this finding contradicts Prashnig’s (2012) suggestion that students in the seventh and eighth grade are at a motivational nadir in their academic career. Another latent consideration for the differential in scores could also be attributed to inequities in sample sizes between groups. The seventh grade comprised the largest sample affording a mathematical advantage regarding score distribution and computations of measures of central tendency.

Seashore (1931) defined three primary acoustic properties of vibrato as, rate, extent and shape. The mechanism for producing an oscillation cycle that yields these properties involves physically pivoting a finger around a central position on the instrument’s fingerboard. Analysis of data by instrument was employed as the third supplemental variable to examine the influence of instrument type on learning vibrato. Descriptive data in Table 8 illustrates that relationships between violinists, violists, and cellists remained relatively static between pretest and posttest however cellists demonstrated the most progress from pre to posttest as evidenced by their means of difference score. Notably, data for the double bass was omitted from Table 8 due to the
sample size of bassists (N = 1), prohibiting the computation of measures of central
tendency.

Progress of the cellists may be attributed to the orientation of playing position for
that instrument as being more conducive to facilitating the signature vibrato oscillation
motion with ease. Two prerequisites for vibrato readiness that appear to be universally
agreed upon by string teachers are lack of tension in the left arm and hand, and proper
positioning on fingers on the fingerboard (Galamian, 1948, Young, 1978, Lucktenberg,
1994, Fischbach, 1997, Rolland, 2000). Without these fundamentals in place, vibrato is
essentially inaccessible. Instruments that are held perpendicular to the floor such as the
cello and double bass facilitate meeting these prerequisites with greater ease than do
horizontally held instruments like the violin or viola that must be balanced on the left
shoulder. In addition, the approach of the left arm and hand in order to play the violin and
viola is less natural and requires more effort to attain a readiness level appropriate for
vibrato. Conversely, left arm positions for the cello and double bass are more organic,
requiring less adjustment to the player’s posture. Furthermore, the use of an endpin as the
balance point for the cello and double bass afford the player more security, therefore
diminishing the potential for tension in the left arm. The violin or viola by contrast
depend upon a shoulder rest and chin rest for balance that may take longer to develop
comfort with overcoming the fear of dropping the instrument. As a result many student
violinists and violists resort to gripping the instrument’s neck with the left hand for added
security that in turn produces tension counter intuitive to vibrato.

Frequency distributions in figures 7, 8, and 9, appear to support this line of
reasoning. For clarity, two subsets of data corresponding to horizontal instruments (e.g., violin and viola), and vertical instruments (e.g., cello and double bass) will be employed to facilitate discussion of this point. In the pretest, twenty three horizontal instrumentalists scored at or above the median score of 8.33, compared to five vertical instrumentalists. Twenty three horizontal instrumentalists achieved posttest means at or above the posttest median of 12.1 compared to 10 vertical. Immediately, no change in the number of horizontal instrumentalists between pre and posttest were observed however five more vertical instrumentalists progressed. Continuing, 17 horizontal instrumentalists attained a means of difference at or above the median of 3.76, compared to 12 vertical who achieved the same. Examining this as raw data implies that horizontal instrumentalists outperformed their bass clef counterparts however employing distributions proportionate to sample size yields that 71% of vertical instrumentalists demonstrated improvement versus 39% of horizontal. It is important to recognize the risk of skewed results however stemming from the disproportion of sample sizes compared between; horizontal (N = 44) and vertical (N = 17) instruments.

It was observed by the researcher that participants who played horizontal instruments in this study did reap an unmeasured residual benefit from the intervention regarding their playing posture. Some violinists and violists who participated soon deduced the relationship of arm, hand, and finger position with the ability to produce a vibrato oscillation and the stigma of vibrato as an advanced skill and symbol of musical maturity, inspired adjustments. As a result, a noticeable improvement in the playing
posture among violinists and violists was observed throughout and after the study although no data were collected on this.

**Conclusion**

Of all the skills that string players strive to develop, perhaps none is as coveted as vibrato. At the conclusion of the current study, it was observed that students continued to practice the newly introduced skill in the context of their orchestra classes although it was no longer required. Furthermore, students on more than one occasion requested to continue vibrato lessons following the conclusion of the study. Perhaps this is because as Lamb (1990) recognized, vibrato is the element ranking second in importance only to intonation among student string players. Lee (2000) admitted that vibrato is “one of the most crucial elements in the beauty of musical performance,” describing it as the “factor by which artistic performance is judged.” (p. 1), yet few studies exist addressing how to teach vibrato. The majority of vibrato literature is diagnostic focusing on acoustic properties in lieu of pedagogy. Nelson (1983) went as far to identify technique in general as a severely under-researched area in music education research. The lack of a standard approach to teaching vibrato could be one reason responsible for discouraging tutorial research on it.

The objective of this study was to investigate one possible approach to teaching vibrato through accessing dominant learning styles of students. Other vibrato studies namely those by Gillespie (1997) and Shepherd (2004) investigated alternative approaches to vibrato instruction using visual or audio/visual presentations. The distinct
approach of the current study recognized three possible sensory paths for learning as visual, auditory and kinesthetic concurring with Dickey’s (1991) recognition of sensory learning models as viable options for teaching instrumental techniques in the classroom.

Readers are reminded to interpret the results of this study cautiously remembering that the findings presented are applicable only to the sample that participated. Results should not be considered generalizable due to the small sample size and conditions (e.g., attendance, disruptions imposed by the schedule, and ambient distractions to the learning environment), which may have influenced the findings. For instance, seventh grade students met on an alternating A/B day schedule opposite of physical education during the second semester in order to accommodate access to a full complement of exploratory arts classes. As a result, the absence rate among seventh grade students from lessons was higher than among their eighth and sixth grade peers and modifications to this schedule extended beyond the researcher’s control. Attendance was further compromised in the after school lessons as a result of students who participated in winter sports, and various other extra-curricular activities. Such occurrences dramatically impacted attendance of seventh and sixth grade students who met the last two periods of the school day, the time during which the majority of dismissals occur.

Challenges to negotiating the personalities of each group were compounded by the teaching environment. Some of the smaller groups were able to be taught in the music office which afforded moderate privacy and isolation, although exterior windows facing into the hallway at times invited distraction. In some cases, larger groups needed to be located in the cafeteria after lunch, which is a central location in the building highly
accessible and therefore not immune to interruptions. The majority of the lessons occurred in a music classroom in center of a three room suite that provided more favorable conditions than the cafeteria, although not free from the ambient sound from the choruses and orchestras rehearsing in the adjacent rooms.

**Recommendations for Future Research**

Results from this study have indicated that accommodating individual learning styles has no significant effect on the acquisition of vibrato on stringed instruments among middle school students supporting Brown’s (2003) conjecture that aligning teaching style with learning style is not a guarantee for student success. Eastman (2004) and Williams (2010) suggested however that data supporting or refuting the value of accommodating learning styles is inconclusive at best. Korenman and Peynircioglu (2007) cited sensory preferences as meaningful to learning melodic patterns however, despite that Mason (1990) failed to find a correlation between sensory mode and music reading. In light of the ambiguity surrounding learning styles research and the need for robust tutorial studies in string vibrato, future researchers interested in the objective of this study are invited to consider modifications based on the following recommendations:

- A larger population could assist in strengthening the generalizability and reliability of the findings, particularly where data were skewed by sample sizes.
- Employ an alternate instrument to identify learning preferences whose validity and reliability can be verified through data.
- Incorporate vibrato readiness as part of the early phase of pretest vibrato assessment.
• Investigate how this teaching approach might influence development of other skills besides vibrato.

• Allow for an extended intervention period recognizing the difficulty level of learning vibrato.

• Collect data on peripheral effects such as posture, intonation and performer satisfaction.

• Consider using a personality indicator such as the Myers-Briggs Type Indicator to examine any correlation between the uniqueness of vibrato expression and student personality types.

Historically, teacher-centric approaches have dominated education where the dynamic was polarized one way from teacher to student; the teacher lectured and the student presumably learned. Even in music classrooms, Pontious (1982) recognized that 42% of active rehearsal time among band directors is spent talking, discussing and verbally instructing. According to Kerner (1969) however, language or even printed material alone is seldom sufficient for learning. Novices introduced to any new skill need to be shown how and given ample opportunities to explore and negotiate for themselves. According to Doyle, and Rutherford (1984) perceptual sensory modalities are one of four educational approaches that hold the greatest implication for improving the learning process. Furthermore, Willingham (2005) even suggested that, “all students learn more when the content drives the choice of modality” (p. 1). Witt (1986) agreed observing that, “student attentiveness in music classes appears to be a function of activity” (p.35), and that “although the activity of playing an instrument, in and of itself, does not guarantee
learning, students might prefer practicing the correct response over listening to the teacher talk” (Witt, 1986, p.40).

Inevitably this study failed to find any significant evidence supporting that sensory learning based instruction had any effect upon student learning specifically with vibrato. It is worthwhile however, to recognize that both sensory learning and vibrato share some common although not exclusive traits that were not addressed by this study. Foremost, both are fundamentally human characteristics. Senses are a basic human capacity as noted by Piaget (1970), who suggested that sensory schemas are a child’s first representation of information. Likewise, vibrato has been described as an irreplaceable and irreproducible form of sincere human expression that no technological effort available can artificially reproduce (MacLeod, 2006). Furthermore, both sensory aptitude and vibrato can both be regarded though in separate arenas, as examples of superior development. Gardner (1985), described intelligence as a “process [that] begins with information delivered to the eye or ear and only concludes when an answer has been issued by the mouth or hand” (p. 22), agreeing with empiricist John Locke’s claim that “sensations are the sole basis of knowledge and the elements of all awareness” (Gibson, 1968, p.48). Conversely, vibrato has been recognized as an advanced technique that defines musical maturity as well as the mechanism that gives beauty, depth and life to musical tone (Harper 1996; Mozart, 1787).

Although no single learning modality was found to be superior for teaching and learning vibrato, there appears to be an underlying relationship between sensory learning and vibrato. The complexity of vibrato technique appears to be best addressed through
engaging multiple modalities simultaneously agreeing with previous research by Gillespie (1997). Therefore, in the spirit of contributing to the sparse population of existent tutorial research in string literature, music educators are urged to revisit the suitability of sensory teaching for teaching complex techniques such as vibrato to affect a focal shift from teacher to student and subsequently invest students in a more satisfying musical experience.
Appendix A

Waveform Representations of Vibrato Characteristics

Figure 1. Vibrato rate represented by six oscillation cycles within a period of one second.

Figure 2. Vibrato extent represented by the width of frequency fluctuation above and below the fundamental starting pitch.
Figure 3. Vibrato shape represented by the directional path of frequency fluctuation from starting pitch. The solid line and arrows depict the customary direction of the oscillation as it begins, rising above the fundamental. The broken line depicts the alternative shape formed when the oscillation begins by dropping below the fundamental.
Appendix B

Research Diary

Protocol 3331E

1/13/2014 to 2/21/2014

This diary is chronicled account detailing the daily intervention of instruction delivered to three experimental groups, visual, auditory and kinesthetic, and one control group during lessons including observations and discussions that occurred. One group was formed in each grades ranging from 6th to 8th and all four groups were scheduled to meet for 12 30 minute lessons.
Description of exercises employed with all groups during intervention:

• “Swingplop” With the instrument in playing position, the left arm swings freely and relaxed imitating an elephant trunk. On cue, the arc of a swing is completed by seating or “plopping” the fingers on the neck of the instrument. (p. 2, #1)

• “Shake, Rattle, and Roll” Rocking of a closed fist, bending at the wrist to simulate knocking on a door. (p. 3 #3)

• “Palm Pats” Also called “Handpats” for cellos and basses. The thumb is positioned at the heel of the neck and with fingers curved, the hand pivots on the thumb so that the fingertips tap the body of the instrument. (p. 4, #4)

• “Tween Taps” Like palm pats but fingers tap in between strings instead of on the body. (p.7, #8)

• “Sticky Taps” Like tween taps but on cue, 2nd finger is secured on the string absorbing the remaining momentum of the tapping motion. (p.8, #11)

• “String Polishing” Fingers slide up and down the neck in a simulated polishing motion along the length of the strings. Violins and violas do this in banjo position, cellos and basses in normal playing position. (p.5, #6D)

• “Stringshine” Like string polishing but violins and violas are now in playing position. Cellos and basses are in normal playing position. (p.7, #10)

• “Wave” Done in playing position, left thumb is braced on the heel of the neck as in palm pats. With fingers extended upward exposing the palm, the hand is pivoted at the wrist and on the thumb in a waving motion while bowing an open string. This exercise encourages independent dexterity between the left and right hands. (p. 6, #7)

This sequence was employed for consistency with the order in which these exercises are presented in the Art of Vibrato DVD which two of the groups used as their primary instructional resource.
Visual Diary

Lesson #1

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- Watched each exercise twice before practicing it. 1st attempt at vibrato on 2nd finger F natural.

Lesson #2(#1)

- V-8 V-7 V-6
- January 14 after school
- No participants present

Lesson #3

- V-8 V-7
- January 17

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- string polishing (banjo position for vlns/vlas)

Vibrate on random upper position note bracing thumb against heel of neck.

Lesson #4(#2)

- V-8 V-7 V-6
- January 21 after school
- No participants present

Lesson #5

- V-8 V-7
- January 24

Reviewed exercises together using video and formed circle so that students can watch each other while practicing the following exercises:

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- string polishing
- stringshine (polish in playing position.)

Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4
(Lesson #3) V-6
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- Watched each exercise twice before practicing it. 1\textsuperscript{st} attempt at vibrato on 2\textsuperscript{nd} finger F natural.

Lesson #6(#4) January 27 after school
No participants present

Lesson #7(#5) January 28 after school
No participants present

Lesson #8(#6) V-8 V-7 V-6 January 30
Reviewed exercises together using video and formed circle so that students can watch each other while practicing the following exercises:
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4, vibrato on D major Scale pitch = whole note.

Lesson #9(#7) V-8 V-7 V-6 February 4
Reviewed exercises together using video and formed circle so that students can watch each other while practicing the following exercises:
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4, vibrato on D major Scale pitch = whole note.
Lesson #10(8)  February 4 after school
No participants present

Lesson #11(9)  V-8 V-7 V-6  February 5
No School due to Weather

Lesson #12(10)  V-8 V-7 V-6  February 11
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Vibrato alternating fingers in sequence: 2, 3, 1, 4, vibrato on D major Scale pitch = whole note.
Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Lesson #11  February 11 after school
2 participants from V-7
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Vibrato alternating fingers in sequence: 2, 3, 1, 4, vibrato on D major Scale pitch = whole note.
Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Lesson #12  V-6  February 17
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Vibrato alternating fingers in sequence: 2, 3, 1, 4, vibrato on D major Scale pitch = whole note.
Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Observations and comments:
Student comment:  All of the examples are for violins and violas, what about cello?
Why do we do the same things every lesson?
Auditory Diary

Lesson #1

A-8 A-7

January 14

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- Listened to each exercise twice before practicing it. 1st attempt at vibrato on 2nd finger F natural.

Discussion about what is vibrato and how does one make pitch changes on these instruments?

Lesson #2

January 15 after school

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- Listened to each exercise twice before practicing it. 1st attempt at vibrato on 2nd finger F natural.

Discussion about what is vibrato and how does one make pitch changes on these instruments?

Lesson #3(#1)

A-8 A-7 A-6

January 21

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing

Vibrate on random upper position note bracing thumb against heel of neck.

Lesson #4(#2)

January 22 after school

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing

Vibrate on random upper position note bracing thumb against heel of neck.
Lesson #5(#3)  A-8 A-7 A-6  January 27

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing
- stringshine (polish in playing position.)

Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4

Lesson #6(#4)  January 29 after school

No participants present

Lesson #7(#5)  A-8 A-7 A-6  January 31

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing
- stringshine (polish in playing position.)

Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4 Vibrato on D major Scale pitch = whole note.

Lesson #8(#6)  February 3 after school

No participants present

Lesson #9(#7)  February 5 after school

No School due to Weather

Lesson #10(#8)  A-8 A-7 A-6  February 6

- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4 Vibrato on D major Scale pitch = whole note.
Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Lesson #11(#9) A-8 February 12
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4 Vibrato on D major Scale pitch = whole note.
Practice posttest excerpt with vibrato to contextualize changing finger patterns.

**No A-7 A-6 due to early release from school for faculty meetings.**

Lesson #12 (#10) A-6 February 12 after school
Cancelled due to meetings

Lesson #11 A-6 February 18
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing
- stringshine (polish in playing position.)
Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4 Vibrato on D major Scale pitch = whole note.
Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Lesson #12 A-6 February 19 after school
No participants present
Control Diary

Lesson #1 C-8 C-7 January 15
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- Practiced each exercise twice before practicing it. 1st attempt at vibrato on 2nd finger F natural.

Discussion about what is vibrato and how does one make pitch changes on these instruments?

Lesson #2 January 16 after school
No participants present

Lesson #3(#1) C-8 C-7 C-6 January 22
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing

Vibrate on random upper position note bracing thumb against heel of neck.

Lesson #4(#2) January 23 after school
No participants present

Lesson #5(#3) C-8 C-7 C-6 January 28
- swing plop
- shake rattle and roll
- palm pats
- tween taps
- sticky taps
- string polishing
- stringshine (polish in playing position.)

Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4

Lesson #6(#4) January 30 after school
Cancelled due to faculty meeting
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<td>C-8 C-7 C-6</td>
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<td>#11</td>
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<td>swing plop, shake rattle and roll, palm pats, tween taps, sticky taps, string polishing, stringshine (polish in playing position.)</td>
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</table>
Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4 Vibrato on D major Scale pitch = whole note.
Practice posttest excerpt with vibrato to contextualize changing finger patterns.

<table>
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Description of modifications to exercises for presentation to kinesthetic group during intervention:

- **“Swingplop”** With the instrument in playing position, the left arm swings freely and relaxed imitating an elephant trunk. On cue, the arc of a swing is completed by seating or “plopping” the fingers on the neck of the instrument. (p. 2, #1)
  - **Cue words:** “Grandfather clock arm” simulating the swing of a pendulum.

- **“Shake, Rattle, and Roll”** Rocking of a closed fist, bending at the wrist to simulate knocking on a door. (p. 3 #3)
  - Using egg shakers, two motions are practiced. **Cue words** for violins and violas “door knock”, cellos and basses “salt on your dinner”

- **“Palm Pats”** Also called “Handpats” for cellos and basses. The thumb is positioned at the heel of the neck and with fingers curved, the hand pivots on the thumb so that the fingertips tap the body of the instrument. (p. 4, #4)
  - To simulate the wrist motion involved for violins and violas, students fling yo-yos with their left hands, palm up, knuckles down before flipping their hands to retrieve the yo-yo on its return. Cellos and basses cast their yo-yos palms down using the whole arm. **Cue word:** “yo-yo wrist”

- **“Tween Taps”** Like palm pats but fingers tap in between strings instead of on the body. (p.7, #8)
  - **Cue word:** “yo-yo strings”

- **“Sticky Taps”** Like tween taps but on cue, 2nd finger is secured on the string absorbing the remaining momentum of the tapping motion. (p.8, #11)
  - Students are introduced to realizing the sensation of rocking on a fingertip using silly putty. Once the putty is flattened out into a circle, they are told, “make a fingerprint using your second finger.” **Cue word:** “putty fingers”

- **“String Polishing”** Fingers slide up and down the neck in a simulated polishing motion along the length of the strings. Violins and violas do this in banjo position, cellos and basses in normal playing position. (p.5, #6D)
  - Each student is given a small square of tissue and told to polish the strings. **Cue word:** “banjo polish” to establish the difference in position between this exercise and stringshine.
• **“Stringshine”** Like string polishing but violins and violas are now in playing position. Cellos and basses are in normal playing position. *(p.7, #10)*
  o Same procedure for string polish, except students are directed into playing position. To discriminate between the two polishing exercises, **cue word:** “playing polish” is used.

• **“Wave”** Done in playing position, left thumb is braced on the heel of the neck as in palm pats. With fingers extended upward exposing the palm, the hand is pivoted at the wrist and on the thumb in a waving motion while bowing an open string. This exercise encourages independent dexterity between the left and right hands. *(p. 6, #7)*
  o Student’s left hand is positioned at the heel of the neck by the teacher for this exercise. Motion is executed on **cue words:** “yo-yo wave and play”
Kinesthetic Diary

Lesson #1 K-8 K-7 January 16
Began with simulated door knock motion, swing plop, motion using yo-yos and egg shakers. Motion is practiced out of rhythm first, and then in rhythm using a metronome. Cellists practice door knob handshake motion.

Lesson #2 January 17 after school
No participants present

Lesson #3(#1) K-8 K-7 K-6 January 23
Yo-yos and egg shakers. Motion is practiced out of rhythm first, and then in rhythm using a metronome. Cellists practice door knob handshake motion. 1st attempt at vibrato on string (2nd finger).

Lesson #4(#2) January 24 after school
No participants present

Lesson #5(#3) K-8 K-7 K-6 January 29
Yo-yos and egg shakers. Motion is practiced out of rhythm first, and then in rhythm using a metronome. Egg shakers at the base of the neck, (Palm pats), on strings (Tween Taps, Sticky Taps string skating (String Polishing banjo position for vlns/vlas), introduced Stringshine (polish in playing position.) Vibrate on random upper position note bracing thumb against heel of neck. Introduced vibrato alternating fingers in sequence: 2, 3, 1, 4 on cue.

Lesson #6(#4) January 31 after school
No participants present

Lesson #7(#5) K-8 K-7 K-6 February 4
Egg shakers at the base of the neck, (Palm pats), on strings (Tween Taps,) Sticky Taps string skating (String Polishing banjo position for vlns/vlas), introduced Stringshine (polish in playing position.) Vibrate on random upper position note bracing thumb against heel of neck. Silly putty fingerprints. Vibrate in alternating finger sequence: 2, 3, 1, 4 on cue. D major scale pitch = whole notes. Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Lesson #8(#6) February 7 after school
No participants present

Lesson #9(#7) K-8 K-7 K-6 February 10
No school due to weather
Lesson #10(#8)          K-8 K-7 K-6          February 14
Egg shakers at the base of the neck, (Palm pats), on strings (Tween Taps,) Sticky Taps string skating (String Polishing banjo position for vlns/vlas), introduced Stringshine (polish in playing position.) Vibrate on random upper position note bracing thumb against heel of neck. Silly putty fingerprints, in alternating finger sequence: 2, 3, 1, 4 on cue. D major scale pitch = whole notes. Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Lesson #11(#9)          February 14 after school
No participants present

Lesson #12(#10)          February 17 after school
No participants present

Lesson #11          K6          February 20
Palm pats, Tween Taps, Sticky Taps String polishing (banjo position for vlns/vlas), Stringshine (polish in playing position.) Vibrate on random upper position note bracing thumb against heel of neck. Vibrato alternating fingers in sequence: 2, 3, 1, 4, vibrato on D major Scale pitch = whole note. Practice posttest excerpt with vibrato to contextualize changing finger patterns.

Lesson #12          K-6          February 21 after school
No participants present
## Appendix C

### Table 12

**Grade 6 Scores and Raw Data**

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<th>Instrument ID</th>
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### Appendix D

#### Table 13

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*Pretest* and *Posttest* values represent performance before and after training, respectively. *Diff* values indicate the difference in performance. The table shows the results for different judges (Judge 1, Judge 2, Judge 3) and instruments (Violin 724, Violin 711, Violin 720, Violin 705).
Appendix E

Table 14
Grade 8 Scores and Raw Data

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Appendix F
Permission to Conduct Research in the Concord School District

Concord School District
School Administration Unit #8

Donna E. Palley
Assistant Superintendent

Christine C. Rath
Superintendent

Jack Dunn
Business Administrator

Robert M. Belmont
Director of Student Services

Larry Prince
Director of Human Resources

T. Mathew Cashman
Director of Facilities and Planning

June 20, 2013

Mr. Anthony Varga
6 Harrington Drive
Merrimack, NH 03054

Dear Tony:
I have reviewed your research plan with Rundlett Principal Tom Sica and give my permission to conduct this research at Rundlett Middle School. I assume all staff participating will do so voluntarily and that you will be obtaining parental permission for a student to be a participant.
I wish you well as you undertake this investigation.

Sincerely,

Dr. Christine C. Rath
Superintendent of Schools
June 20, 2013

Dear Sir or Madam:

Recently, I had the opportunity to meet with Anthony Varga, a music teacher at Rundlett Middle School, to review a proposal to conduct research as part of his Doctorial Dissertation. As Principal of RMS, I give Anthony my full support to pursue this research.

The Concord School District values and has a strong tradition of excellence in its music and arts program. Rundlett Middle School is pleased to assist Anthony as he pursues his doctoral studies.

Sincerely,

Thomas M. Sica,
Principal
Appendix G

Notification of Boston University IRB Approval

Boston University Charles River Campus Institutional Review Board

25 Buck Street
Room 157
Boston, Massachusetts 02215
T 617-358-5115
www.bu.edu/irb

Notification of IRB Approval: Expedited Review

November 29, 2013

Anthony C. Varga
College of Fine Arts
Music Education
Boston, MA 02215
varganthony@comcast.net

Protocol Title: Effectiveness of Grouping Middle School Students Based on Learning Modality Preferences on Vibrato Acquisition
Protocol #: 3331E
IRB Review Type: Expedited Category 7

Dear Mr. Varga:

On November 29, 2013 the IRB reviewed and approved the above referenced protocol via expedited procedures in accordance with 45 CFR 46.110. Approval for this study is effective from November 1, 2013 to October 31, 2014.

In accordance with 45 CFR 46.404 and 46 CFR 46.408, the IRB determined that the research did not involve greater than minimal risk; that assent would be obtained from the child, and that the permission of one parent is sufficient. Assent will be obtained through a written assent form.

This approval includes the following:
1. Student Assent Form
2. Parental Consent Form
3. Vibrato Evaluation Instrument
4. The Vark Questionnaire-The Younger Version
5. Pachelbel Canon in D

This approval is valid for one year, and will expire on November 28, 2014. Please submit a Progress Report, which is located on our website (http://www.bu.edu/irb), six weeks prior to the expiration of your study.

As the Principal Investigator, you are responsible for ensuring that studies are conducted in accordance with federal regulations, state laws, and institutional policies.

Please note:
• No subjects may be involved in study procedures prior to the IRB approval date or after the expiration date.
• All unanticipated problems or serious adverse events must be reported to the IRB immediately.
• All protocol modifications must be approved by the IRB prior to implementation unless they are necessary to eliminate immediate hazard to subjects.
• All protocol deviations must be reported to the IRB.
• All recruitment materials and methods must be approved by the IRB prior to use.

If you have any questions, please contact me at 617-358-6115.

Sincerely,

Patricia Seymour, CCRC, MA, CIP
IRB Analyst
Charles River Campus IRB

cc: Manny Brand
brandm@bu.edu
Appendix H

Informed Consent and Assent Forms

EFFECTIVENESS OF GROUPING MIDDLE SCHOOL STUDENTS BASED ON LEARNING MODALITY PREFERENCES ON VIBRATO ACQUISITION

STUDENT ASSENT

I would like to invite all of you to participate in this research study that I am conducting. Your participation is very valuable to the completion of this research. What’s in it for you? First off, you’ll learn something about the way that you learn which could be helpful to you in other classes as well. Second, you’ll have an opportunity to begin learning very difficult and complex technique on your instrument that we don’t always have the chance to introduce in class. Finally, I need to mention that participating in this study will not cost you anything, and will not influence or affect your grade in any way. Also, please be aware that you have the right to quit participating at any point during study, without explanation. I just ask that you let me know that you no longer wish to participate and there will be no consequences on your part for your decision.

The study is an investigation into different ways that music teachers might teach vibrato to their students. This will involve several steps however which I’ll explain to you. First, I’ll need to identify your individual learning styles. I’ll do this by giving you a brief and simple learning styles assessment questionnaire that’ll ask you to answer some questions about how you might respond in certain situations. After you complete the questionnaire, together, we’ll do some simple math to score these and in a short time, you’ll know how you learn best, or which of your senses that you rely on most when learning. You may have heard before that people who tend to learn by watching or through looking at pictures are called visual learners. Those who prefer listening are called, auditory learners and those who prefer doing things hands on or through movement are called, kinesthetic learners. It is even possible that your scores may show that you use a combination of these equally in which case you would be considered a multi-modal learner. Next, I’ll divide you into groups by learning style, not by instrument type. Over the course of the next six weeks of the study, I’ll be teaching you vibrato by matching my teaching approach to each group’s learning style, so the visual learners will learn through watching, the auditory learners through listening and the kinesthetic by movement. I’ll need to record you performing twice to gather my data and arrive at a conclusion at the end. One recording will be at the beginning of the study, and one at the end. We call these the pre-test and posttest. In no way though will the “tests” affect your grade. They’re not playing tests for class, just information that I need to complete the study. Everything about this study is apart and separate from your grade and standing in the orchestra class, including whether or not you choose to participate.
The group lessons will be done during your regularly scheduled orchestra class and once a week after school for 30 minutes. For example, if you’re in the visual group, I’d be asking you to attend an after school lesson on Mondays until the study is done. It’ll only be six after school lessons so hopefully, that won’t be a big deal for you. If that presents a problem, then please feel free to speak with me.

If you’d like to participate in this research study, then I need you to sign and return the permission slip to me by **Friday, December 20th**. Finally, I need to mention again that I do not want you to feel any pressure to participate or worry that anything I discover in this study will be used to influence your grade, or judge you as a student or musician. I sincerely hope that you decide to join the study because your input is very valuable to me.

I appreciate your help with this and thank you in advance for considering being part of my work. If you have any questions please feel free to ask or speak with me privately.

**************************************************************************************************************

I have read the description of the study and I understand what is expected of me if I participate in the study described above. By signing this document, I give my permission to participate in this research study.

---

**Printed Name**

**Date**

**Student Signature**
Dear Orchestra Parent,

I am writing to you not as your child’s music teacher but as a graduate student who is in the final phase of completing a dissertation at Boston University in fulfillment of a Doctorate of Musical Arts degree. The culmination of completing this degree involves conducting a research study that will contribute to the body of research literature in the field of music education. Therefore in preparation to satisfy this goal, I would like to ask your help in allowing your child to participate in my research study which will be conducted at Rundlett Middle School. All of the details regarding the study are outlined below and I invite you to please contact me should you have any questions regarding this project.

**Title of Study:** EFFECTIVENESS OF GROUPING MIDDLE SCHOOL STUDENTS BASED ON LEARNING MODALITY PREFERENCES ON VIBRATO ACQUISITION

**Principal Investigator:**
Name: Anthony C. Varga
Department: Boston University College of Fine Arts
Address: 144 South Street Concord, NH 03301
Phone: (603) 225 – 0800 extension 6695
E-mail: avarg@concordnhschools.net

**Background:**
Your child is being invited to take part in a research study. Before you decide to consent their participation in this study, it is important that you understand why the research is being done and what it will involve. Please take the time to read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to investigate the effectiveness of teaching and learning vibrato on stringed instruments by matching instructional delivery with individual student leaning preferences, (i.e., visual, auditory, and kinesthetic modalities)

**Study Procedure:**
Your child will be involved in the study of a period on eight weeks or one marking period quarter during which they will participate in two recorded assessments and receive a treatment of lessons over a six week period.

The specifics of the procedure will include three phases, consisting of a pretest, treatment, and posttest. The initial phase will engage subjects in a vibrato pretest to assess existing skill level and establish a baseline for the study. Next, ten subjects will be randomly assigned to a control group and the remaining subjects will be administered VARK (Fleming, 2001), a learning preference profile whose name is derived from the
four preferences that it identifies as Visual, Auditory, Read/Write, and Kinesthetic, to assess learning preferences as visual, auditory or kinesthetic. Based on data collected from VARK (Fleming, 2001), three experimental groups will be formed corresponding to visual, auditory or kinesthetic.

The second phase will consist of a treatment period in which each group will receive a course of 12, 30 minute group vibrato lessons over the duration of six weeks. Instruction during the lessons will be tailored to accommodate matching learning modality preferences of each experimental group. The visual group will be presented with a video modeling appropriate vibrato technique. The auditory group will listen to quality recordings of model vibrato and the kinesthetic group will engage in exercises that simulate the motion of vibrato production. The control group will be taught using Viva Vibrato (Fischbach, 1998), a vibrato exclusive method book designed for use in a heterogeneous classroom to simulate a traditional whole class approach. Data will be collected from the pretest, mid-term assessment and posttest and will be recorded via a Zoom H2 handheld digital recorder whereupon audio files will be transferred to and archived on compact disc via a laptop computer. Recordings will be evaluated by a panel of string specialists employing Gillespie’s (1993) vibrato evaluation form to assess developmental maturity. Data collected from the vibrato performance pretest and posttest will be subjected to Kruskal-Wallis H test. In addition means of central tendency and frequency distributions will be computed as descriptive statistics.

**Risks:**
The risks of this study are minimal. These risks are similar to those that your child may experience when participating in any recorded educational assessment. You may decline to have your child participate should the experience become uncomfortable at any point during the study.

**Benefits:**
There will be no immediate direct benefit to you or your child for your participation in this study. However, I hope that the information obtained from this study may assist in advancing the methods of instructional delivery for teaching vibrato and possibly other skills on stringed instruments in the future.

**Alternative Procedures:**
If you do not wish for your child to be in the study, you decline their participation in which case your child will remain in the population of the orchestra class during the study and not be exposed to the instructional treatment at no risk nor affect to their grade. Participation in this study is by no means linked in any manner to your child’s grade in the orchestra class.

**Confidentiality:**
Due to the personal contact inherent in the face to face instructional model employed in this study, I as the researcher will be the only person privy to identifying the participants
during the treatment. For the purpose of reporting data, all data will be codified using a
generic reference number that will replace your child’s name so that any data submitted
for evaluation will remain anonymous and protect your child’s privacy.

Furthermore, all references to your child’s data that is reported in the dissertation will be
anonymous and use reference numbers to protect their privacy. In addition, should you
wish to obtain a transcribed copy of your child’s data, please feel free to contact me and I
will be happy to provide you with a copy of any or all parts of your child’s data.

Person to Contact:
Should you have any questions about the research or any related matters, please contact
the researcher at [redacted] or [redacted].

Institutional Review Board:
Should you have any concerns regarding this study, you may obtain further information
about your rights as a research subject by calling the BU CRC IRB Office at 617-358-
6115.

Voluntary Participation:
Your child’s participation in this study is voluntary. It is up to you to decide whether or
not you wish for your child to take part in this study. If you do decide to consent their
participation, then you will be asked to sign a consent form. Furthermore, reserve the
right to withdraw your child from the study at any time and without giving a reason
without any affect upon the relationship you or your child have with the researcher.

Unforeseeable Risks:
There may be risks that are not anticipated. However every effort will be made to
minimize any risks.

Costs and Compensation to Subjects:
There will be no costs or compensation to you or your child for participation in this
study.
Title of Study: EFFECTIVENESS OF GROUPING MIDDLE SCHOOL STUDENTS BASED ON LEARNING MODALITY PREFERENCES ON VIBRATO ACQUISITION

Consent:
By signing this consent form, I confirm that I have read and understood the information and have had the opportunity to ask questions. I understand that my child’s participation is voluntary and that I am free to withdraw my child at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to have my child participate in this study.

If you find the conditions of this research agreeable and wish for your child to participate in the study, please return the signed portion of this letter to me by Friday December 20th acknowledging you consent.

Student Name
(Printed):__________________________________________________________

Parent/Guardian
signature_________________________________________________________ Date:_________

Thank you in advance for your time and consideration regarding this research initiative.

Respectfully,

Anthony C. Varga
Rundlett Middle School Music Department
Appendix I

Letter of Instructions to Evaluators

January 22, 2014

Dear Barbara, Sally and Muriel,

Thank you for volunteering to help me with my research study. In the folder, you’ll find a compact disc containing all of the pretest recordings, a copy of the performance excerpt and pre numbered score sheets. The sheets are color coded according to grade so the blue ones are 8th grade, pink 7th grade and yellow are 6th grade. I also arranged the recordings in numerical order by grade beginning with 6th, then 7th and finally 8th on the CD. As you listen to each recording, simply score it using the descriptions used in each category. Don’t worry about the composite score; I can take care of that if you want to save time. The critical thing is that the recording on the CD matches the number on the score sheet. As far as the scores, you needn’t spent a lot of time with each recording; a general impression will be fine for this purpose. As I’m sure you’re aware of from your own experiences, the recordings run the gamut of ability from pretty impressive to novice. Don’t worry about it; just use the rubric so that all of the scores are consistently using identical criteria.

If you have any questions, please contact me via email at school [email protected], or home [email protected], or by phone (603) 305-3931.

Lastly, take a little time with this if you need to. Ultimately I won’t be using this data until the end of the study when I compare it to the posttests. Whenever you get this back to me is fine as long as it’s before March. I will contact you again when the posttest recordings are completed and ready for you to evaluate.

Again, you have my most appreciative thanks for helping me with this.

Best Wishes!!
Appendix J

Vibrato Evaluation Instrument based on Gillespie (1993)

Judge________ Subject N umber________

PRETEST
Directions: Please evaluate each vibrato category based on your judgment of vibrato quality of demonstrated on the recordings.

Width
5  Optimal width
4  Better than average width
3  Average width
2  Very narrow or very wide
1  Width not detectable

WIDTH: __________

Speed
5  Optimal speed
4  Better than average speed
3  Moderate speed
2  Very slow or very fast speed
1  Speed not detectable

SPEED: __________

Evenness or Regularity
5  Optimal regularity
4  Better than average regularity
3  Moderate regularity
2  Not regular
1  Evenness undetectable

EVENNESS: __________

Pitch Stability
5  Pitch is stable
4  Pitch varies slightly
3  Pitch varies moderately
2  Pitch is not stable
1  Pitch is undetectable

PITCH STABILITY: __________
# Overall Rating of Vibrato Sound

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<th>Rating</th>
<th>Description</th>
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<tbody>
<tr>
<td>5</td>
<td>Optimal vibrato sound</td>
</tr>
<tr>
<td>4</td>
<td>Better than average vibrato sound</td>
</tr>
<tr>
<td>3</td>
<td>Moderately acceptable vibrato sound</td>
</tr>
<tr>
<td>2</td>
<td>Not a pleasing vibrato sound</td>
</tr>
<tr>
<td>1</td>
<td>Vibrato sound undetectable</td>
</tr>
</tbody>
</table>

**OVERALL VIB QLTY:**

**COMPOSITE SCORE:**
Appendix K

Permission to Use VARK™, the Younger Version

Dear Anthony

Thank you for seeking permission to use VARK™. We welcome VARK users and we appreciate the honesty of people to act in a professional way when using our copyright and trademarked materials. From our beginnings we wanted VARK to be free for use by teachers and students in universities, colleges and high schools. To achieve that we needed to charge fees for those who use VARK as part of their profit or not-for-profit business.

If you are a student or teacher in a high school, college or university you are welcome to use the VARK™ questionnaire by linking to our website, or to use paper copies. We ask that you provide this acknowledgement:


Your use is free of fees and you can download a copy of the VARK Younger Questionnaire or use the one attached.

For Education Users: As you are not permitted to place VARK copyright resources on any online or electronic site, and using paper copies of the questionnaire may not be appropriate, we can gather your data for you. Our VARK Subscription Service does not need any installation on your system. You get to manage the site and to download the results. We capture the VARK scores for your research, your classes or for your whole high school, college or university. The Subscription Service is demonstrated on our website and the cost for six months for an Individual Teacher or a student research project is approximately $US95. An Institutional Subscription is about $US520). We can assist those who want to use paper copies of the VARK questionnaire for their research by processing their data for them free of charge.

Also available is a VARK Profile that provides helpful advice for effective study strategies using your preferences. That can be purchased immediately after completing the VARK questionnaire online but leave your computer running as it will come as download. If you are using VARK™ for research, please note that we have two scoring systems and one is designed specifically for research. The information about each system is at these web addresses:


Book Download: You may find the VARK books helpful. They are all available as immediate and inexpensive downloads. They are sent immediately after payment, so don't shut down your computer until the book arrives as a PDF on your browser.
Restrictions: You may not place VARK copyright materials online or on an electronic survey instrument, or any website or intranet. This applies to using VARK for research, and all publications, free resources and resources made for sale, or for which fees are charged. Fees are also due from trainers who may work with schools/colleges/universities but who are not staff in those organisations. Business users should visit our VARK business site at http://business.vark-learn.com

Best wishes for your learning

Neil

Neil D Fleming
Designer of the VARK Questionnaire
Director: VARK LEARN Limited
50 Idris Road, Christchurch 8052
New Zealand
www.vark-learn.com
http://business.vark-learn.com
phone: (64) 3 3517798
Appendix L

VARK™, the Younger Version

How Do I Learn Best?

The Younger version of VARK

This questionnaire aims to find your preferences for learning. Circle the letter next to your answer. Please select more than one answer if a single answer is not enough. Leave blank any question that does not apply.

1. You like websites that have:
   v. interesting design and visual effects.
   a. audio channels for music, chat and discussion.
   r. interesting information and articles in print.
   k. things you can do.

2. A website has a video showing how to make a special graph. There is a person speaking, some lists and words describing what to do and some diagrams. You would learn most from:
   v. seeing the diagrams.
   a. listening.
   r. reading the words.
   k. watching the actions.

3. You want to plan a surprise party for a friend. You would:
   v. draw a map and make a special design for the invitation.
   a. talk about it on the phone or text others.
   r. make lists of what to do and what to buy for the party.
   k. invite friends and just let it happen.

4. You are going to make something special for your family. You would:
   v. decide from pictures in magazines.
   a. talk it over with my friends.
   r. find written instructions to make it.
   k. make something you have made before.

5. You have been selected as a tutor or a leader for a holiday program. This is interesting for your friends. You would:
   v. show them the map of where it will be held and diagrams about it.
   a. describe the activities you will be doing in the program.
   r. show them the list of activities in the program.
   k. start practising the activities you will be doing in the program.
6. You are about to buy a new digital camera or mobile phone. Other than price, what would most influence your decision?

v. it is the latest design and looks good.
a. the salesperson telling me about it.
r. reading the details about its features.
k. trying it.

7. Remember when you learned how to play a new computer or board game. You learned best by:

v. clues from the diagrams in the instructions.
a. listening to somebody explaining it and asking questions.
r. reading the instructions.
k. watching others do it first.

8. After reading a play you need to do a project. Would you prefer to:

v. draw or sketch something that happened in the play?
a. read a speech from the play?
r. write about the play?
k. act out a scene from the play?

9. You are about to connect your parent’s new computer. You would:

v. follow the diagrams that show how it is done.
a. phone, text or email a friend and ask how to do it.
r. read the instructions that came with it.
k. unpack the box and start putting the pieces together.

10. You need to give directions to go to a house nearby. You would:

v. draw a map on a piece of paper or get a map online.
a. tell them the directions.
r. write down the directions as a list.
k. walk with them.

11. You have a problem with your knee. Would you prefer that the doctor:

v. showed you a diagram of what was wrong.
a. described to you what was wrong.
r. gave you an article or brochure that explained knee injuries.
k. demonstrated what was wrong using a model of a knee.

12. A new movie has arrived in town. What would most influence your decision to go (or not go)?

v. you see a preview of it.
a. you hear friends talking about it.
r. you read what others say about it online or in a magazine.
k. it is similar to others you have liked.
13. Do you prefer a teacher who likes to use:

v. an overview diagram, charts, labelled diagrams and maps.
a. class discussions, online discussion, online chat and guest speakers.
r. a textbook and plenty of handouts.
k. field trips, case studies, videos, labs and hands-on practical sessions.

14. You are learning to take photos with your new digital camera or mobile phone. You would like to have:

v. diagrams showing the camera and how to use it.
a. a chance to ask questions and talk about the camera’s features.
r. clear written instructions with lists and bullet points.
k. examples of good and poor photos and how to improve them.

15. You want some feedback about an event, competition or test. You would like to have feedback:

v. that used graphs showing what you achieved.
a. from somebody who discussed it with you.
r. that used a written description or table of your results.
k. that used examples of what you have done.

16. You have to present your ideas to your class. You would:

v. make diagrams or get graphs to help explain my ideas.
a. write a few key words and say them again an again.
r. write out my speech and learn it by reading it again and again.
k. gather examples and stories to make it real and practical.

Count your choices from both pages

V A R K

© Copyright Version (2014) held by Neil D. Fleming, Christchurch, New Zealand. The main version was revised in 2006 and is at http://www.vark-learn.com
Appendix M

Schedule of Intervention Vibrato Lessons

VIBRATO RESEARCH STUDY LESSON GROUP MEETING SCHEDULE

<table>
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Group designation key:
V = visual group  A = auditory group  C = control group  K = kinesthetic group

Numbers paired with letters correspond to grades.
Ex:  V7 means 7th grade visual learner group.
# Calendar

## January ~ February 2014 ~ March

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Appendix N

Musical Excerpt Employed in Pretest and Posttest Evaluations

Pachelbel Canon in D
References


Eastman, V. L. (2010). *Small group instruction: Reading instruction utilizing learning style preferences and the reading achievement of first grade students*. Ph.D. 3403223, Ball State University, United States -- Indiana. Retrieved from ProQuest Dissertations & Theses Database.


Vita

Anthony C. Varga
6 Harrington Drive
Merrimack, New Hampshire 03054

Personal Information
Born: 1964, New Brunswick, New Jersey
Marital Status: Married

Education
Bachelor of Music (1994), Music Education, Mason Gross School of the Arts, Rutgers University, New Brunswick, New Jersey

Master of Arts (2001), Music Education, Rowan University, Glassboro, New Jersey
  • Thesis: The association between learning processes and formal music electives among sixth grade music students

Doctorate of Musical Arts, (2015) Boston University, Boston, Massachusetts

Association Memberships
  • American String Teachers Association
  • National Association for Music Education

Professional Experience
Franklin Pierce University, Rindge, New Hampshire (2002 – current)
  • Adjunct instructor MU212 Jazz History
  • Adjunct Instructor TH272 Theatre History
  • Basic and intermediate certifications for designing and instructing courses using E college online platform

  • Music teacher and director of orchestras, Concord High School and grade 8, Rundlett Middle School (2009 – current)
  • Coordinator of District Performing Arts Department (2009 -2012)
  • Music teacher and director of orchestras, grades 6 -8, Rundlett Middle School (2003 - 2009)
    o Served on music curriculum revision committee

  • Music teacher grades K - 8, director of band and chorus
Haddonfield Public Schools, Haddonfield, New Jersey (1999 – 2002)
  • District string specialist, director of orchestras grades 3 – 12
    ○ Served on music curriculum revision committee

Glassboro Public Schools, Glassboro, New Jersey (Jan 1996 – 1999)
  • District string specialist, director of orchestras grades 7 – 12
    ○ Served on music curriculum revision committee
    ○ Served on block scheduling committee

Hammarskjold Middle School, East Brunswick, New Jersey (Sept 1996 – Jan 1996)
  • Long term substitute director of orchestras grades 6 – 8

Publications and Papers
Published article in Tempo NJMEA Journal
  • “I’ve got rhythm, I’ve got movement, who could ask for anything more?” (Oct 1999, p.14)

Other Experience
Active in Music Ministries in the following parishes:
  • St. Patrick’s R.C. Church, Milford, New Hampshire, (2010 – current)
  • St. Patrick’s R.C. Church, Milford, New Hampshire, (2002 – 2007)
  • Our Lady of Good Counsel R.C. Church, Moorestown, New Jersey (1990 -2002)

Active performing bassist in community theatre productions and community orchestras
(1990 – current)
  • Mainstage Center for the Arts, Williamstown, NJ
  • Central Jersey Symphony Orchestra, North Branch, NJ
  • Philharmonic of Southern New Jersey, Evesham, NJ
  • RB Productions, Concord, NH
  • Majestic Theatre, Manchester, NH
  • Peacock Players, Nashua, NH
  • Interlakes Summer Theatre, Meredith, NH
  • New Hampshire Philharmonic, Manchester, NH
  • Lakes Region Symphony Orchestra, Meredith, NH
  • Nashua Chamber Orchestra, Nashua, NH

  • Honorably discharged Quartermaster Petty Officer Second Class, Surface Warfare Qualified