The Effects of Computerized and Traditional Ear Training Programs on Aural Skills of Elementary Students

Zachary R. Ross

Milligan College

Spring 2017

Abstract

The purpose of this study was to investigate the effects of computerized and traditional ear training methods on the aural skills abilities of elementary music students. The sample consisted of 20 students who were randomly assigned to either an experimental or control group. The experimental group was taught for five sessions using computerized ear training program while the control group was taught for five sessions using traditional, non-computerized ear training methods. At the end of the five sessions, students were tested. Data were collected by administering a test to both experimental and control groups that measured students' ability to identify by ear eleven different pitch intervals and three different qualities of chords. Students were also administered a survey to measure their attitudes toward their experience in the ear training program. Data were analyzed using independent t-tests. The results indicated a significant difference between the test scores of the control and experimental groups. There was no significant difference found between the experimental and control groups regarding their attitude survey results. The results of this study suggest the use of computerized ear training instruction is beneficial in achieving aural skills.

Keywords: ear training, music education, computerized instruction, aural skills, intervals, chords

MILLIGAN COLLEGE

Date: 1.23.17

From: The Institutional Review Board (IRB) at Milligan College

Re: The Effects of Computerized and Traditional Ear Training Methods on Aural Skills

Submission type: Initial Submission

Dear Zach Ross,

On behalf of the Milligan College Institutional Review Board (IRB), we are writing to inform you that your study '*The Effects of Computerized and Traditional Ear Training Methods on Aural Skills*' has been approved as expedited. This approval also indicates that you have fulfilled the IRB requirements for Milligan College.

All research must be conducted in accordance with this approved submission, meaning that you will follow the research plan you have outlined here, use approved materials, and follow college policies.

Take special note of the following important aspects of your approval:

- Any changes made to your study require approval from the IRB Committee before they can be implemented as part of your study. Contact the IRB Committee at **IRB@milligan.edu** with your questions and/or proposed modifications.

- If there are any unanticipated problems or complaints from participants during your data collection, you must notify the Milligan College IRB Office within 24 hours of the data collection problem or complaint.

The Milligan College IRB Committee is pleased to congratulate you on the approval of your research proposal. Best wishes as you conduct your research! If you have any questions about your IRB Approval, please contact the IRB Office and copy your faculty advisor if appropriate on the communication.

Regards,
The IRB Committee

Table of Contents

Chapter 1

Introduction

As the field of aural skills instruction is the major focus of this study, it is important to note that aural skills is regarded to be a difficult subject to teach by professionals in music education. In his article advocating a perceptually-based learning hierarchy for teaching aural skills, Edward Klonoski describes how students have more difficulty learning aural skills concepts than other musical skill sets such as notation and interval analysis. As aural skills are more difficult to assess than written theory skills or tangible performance skills, students have more difficulty practicing and mastering these skills. (Klonoski, 2000).

Research supports the notion that aural skills instruction is optimized when it follows a systematic, sequential, hierarchical program in which students begin with basic concepts such as distinguishing between volumes and tempos and finding tonal centers, before graduating to more advanced concepts such as chord analysis and melodic dictation. Regardless of the materials and methods used in instruction, students must first master basic aural skills tasks because they function as critically necessary prerequisites for more advanced skills (Killam, 1984).

To illustrate this technically, theorist John Rothgeb warns against introducing concepts of harmony, inversion theory, or chord analysis to beginning aural skills students too early. Rothgeb argues that a year of strict counterpoint study with figured bass better prepares students to comprehend and analyze harmony than if they were taught to analyze and work within a diatonic system before a contrapuntal one (Rothgeb, 1981). Before learning to comprehend the melodic and harmonic implications of a musical phrase on a large scale, Rothgeb argues, the student must first learn to work with one or two notes at a time in strict counterpoint.

Aural skills researcher Rosemary Killam presents concepts that can be presented to students even before working with one and two note counterpoint. She suggests that as the goal of aural skills instruction is to have students integrate rhythmic and melodic-harmonic skills, students should first learn to hear foreground events before advancing gradually and subsequently to nonadjacent, middleground relationships. According to Killam's findings, the student will benefit by first learning to identify the tonal center and structural points of dissonance and tendency before completing "middleground" individual components such as pitches, intervals, and rhythmic patterns. She suggests primarily using the end of compositions as instructional examples because the ends of compositions provide the most secure and explicit points of tendency and cadence (Killam, 1984).

The other major variable of this study is the use of specifically-designed music education computer technology as an instructional learning tool. A vast amount of research has been conducted on this topic yielding mixed results about the effectiveness of a broad range of computer-based instructional technologies. A study published at Princeton University highlights ways technology can be used to help students learn through active engagement, group participation, frequent interaction, feedback, and connections to real-world contexts. The researchers state the mere existence of technology in the classroom does not ensure its effective use. Their research suggests when instructional technology is tested and shown to be ineffective, the ineffectiveness probably results from improper implementation of the technology into the lesson, rather than resulting from an inherent flaw of the technology itself. Within their study, these researchers also found that students who participate in computer-connected learning networks demonstrate increased motivation and a deeper understanding of concepts (Roschelle, Pea, Hoadley, Gordin, & Means, 2000).

Since the advent of computers and the Internet, research has been conducted about the effectiveness of using technology in music education. Recent studies such as the research published in Andrew Brown's 2007 book, *Music Technology and Education: Amplifying Musicality*, describe how music students can use computer technology to efficiently and effectively learn and practice musical concepts, compose original works, and strengthen more intelligible skills of "musicality." Brown challenges the traditional instructional design of "read-write-listen-perform," arguing that modern technology can be used to provide music students with a deeper, multi-faceted, more meaningful engagement with music (Brown, 2007).

Statement of the Problem

Teaching students to accurately comprehend music involves teaching them to hear the music accurately in their minds just from mentally recalling the music or, in a more advanced stage, seeing the music notated. One of the leading researchers in the field of teaching aural skills, Edward Gordon, calls this term audiation. In his research, he defines audiation as the process by which music is heard and comprehended without being sonically represented or present (Gordon, 1994). According to Gordon, in order to teach students to efficiently "audiate," a series of ear training lessons should be used to teach the student to find the tonal center of a piece as well as distinguish intervallic steps and relationships by ear. The controversy being researched in this study is over the best practice for teaching these ear training and audiation skills. Traditional aural skills instruction is teacher-driven and provides the students with ear training instruction usually taught from a piano and centering around teacher-led exercises with which the students interact. By contrast, computerized instructional technologies allow students to participate in student-driven, computer-based programs in which visual and aural stimuli combine to present a multi-faceted aural skills lesson that can be completed at a pace governed by the student. Therefore, the statement of the problem for this study was to examine the effectiveness of a computerized ear training program compared to a traditional ear training program that does not use computerized technology.

Purpose

The purpose of this study was to investigate the effect of computerized and traditional programs on beginning aural skills concepts. Considering research which supports the notion that students are more motivated to learn when using well implemented instructional technology, using such technology in ear training could prove to be advantageous and effective in the aural skills classroom (Roschelle, Pea, Hoadley, Gordin, & Means, 2000).

Significance

This study was significant as it provided data on a specific, free, Internet-based ear training program which could be used by any student or classroom equipped with Internet-access and electronic devices. Though much research has been conducted concerning using technology in the classroom, using specific music education technology, and exploring various methods of teaching aural skills, this particular, Internet-based, ear training program has not been the focus of an experimental research project.

The significance of this study is also rooted in the need for an easily accessible, economical, aural skills training program that can be used for beginning students of all ages. In an article which presents various strategies for teaching ear training skill sets to high school students, Richard Domek acknowledges the issue of how many freshman music majors have little to no aural skills training compared to performance and music theory experience. Domek argues that the earlier students are exposed to ear training, the better, and that students in grade school should be exposed to aural skills instruction that is concise and economical. Utilizing the methods analyzed in this study would certainly fulfill Domek's recommendation of using a method of aural skills instruction that is efficient, to the point, and tailored specifically to the individual student (Domek, 1979).

Limitations

The following limitations were imposed on this study: Firstly, I was not able to control or definitively know the respective aptitude, ability, and previous musical experience of each of the participants in the study. According to a study published in the *Journal of Research in Music Education*, the effects of musical aptitude, academic ability and previous musical experience were found to be significant in impacting the achievement of students in aural skills programs (Harrison, Asmus, & Serpe, 1994). Like any population of music students, my students all had various degrees of musical experience, aptitude, and ability prior to the study.

The other major limitation of this study was the relatively small sample size. At the time in which the data was collected, the resources were not available to include a large population of participants. Though the findings of this study accurately depict the learning experiences of my participants, it is recommended that this study be replicated with a larger sample size and population.

Definitions

Audiation is the process that takes place when we hear and comprehend music for which the sound is no longer physically present. When a student is able to look at a piece of music notated on paper and hear the music accurately in their mind, they are audiating at an advanced and highly proficient level (Gordon, 1994).

Aural Skills are integral to the study of music theory. These skills involve determining the tonal center, distinguishing chords, scales, and intervals by ear, notating melodies and harmonic progressions by ear, the process of audiation, sight-singing, and all other musical skills that require "hearing music correctly" (Telesco, 1991). Aural skills can be categorized into perception, communication, creation, recreation, prescriptive, and speculative skills. The skills being tested in this study are primarily perceptive, recreative, and prescriptive (Killam, 1984).

Musictheory.net is a free, Internet-based, music theory training program that presents users with lessons, tools, and exercises for music theory and aural skills training. The exercises used in this study were note ear training and interval ear training. The site also offers an iOS application which can be purchased for $2.99 called **Tenuto**. Purchasing this application allows users to access lessons and exercises without Internet access. Participants in the study were not required to acquire this application.

Traditional ear training is an instructor led curriculum in which the instructor uses acoustic instruments and stationery to guide the student through interactive ear training exercises.

Overview of the Study

This study is presented in five chapters. Chapter one consists of an introduction, statement of the problem, a brief discussion of relevant existing research, and an overview of the study. Chapter two presents a critical review of all literature referenced during the study. Chapter three presents the research methods of the study as well as specifics about the collection of data for the project. The findings of the study are presented and discussed in Chapter four. Chapter five includes a review of the study and its findings as well as conclusions and recommendations for further research.

Chapter 2

Review of Literature

In order to achieve proficiency and fluency in Western music, the music student must synthesize visual, aural, and kinesthetic skills which will allow them to clearly and effectively express themselves through mediums of performance, analysis, criticism, and composition. These skills consist of vocal or instrumental technique, ability to interpret visual notation of music, and aural skills. Aural skills include concepts like recognizing and producing the tonal center, distinguishing various instruments, tones, and timbres, the discernment of various intervals and chords, and hearing the quality of scales and modes. The culmination of aural skills is the transcription and transmission of music entirely by ear, a process ethnomusicologists have identified as the global norm for musical instruction and practice (Woody, 2012).

Even though aural skills are essential for every musician, so much so that many musical cultures use only aurally transmitted music over visually notated music, many Western music classrooms sacrifice aural skills instruction for repertoire-based instruction designed to teach students to read and perform visually notated music with the goal of succeeding in concert performances. Most music instructors feel aural skills are important, but do not feel like they are able to sacrifice class and rehearsal time dedicated to refining repertoire in order to scaffold and advance students in their aural skills. Because of the restrictions on time in the classroom and the importance of aural skills to the learning musician, an ear training program that increases efficiency of learning would be greatly beneficial. These contexts illustrate the significance of researching various aural skills training programs (Domek, 1979).

The Importance of Teaching Aural Skills

It is arguable that every person, musician or not, has engaged in informal aural skills training. The activity of simply listening to music, for example, leads listeners to aurally identify concepts such as the mood of the piece or the distinctive voice of a singer or soloist. Though some people only engage with these informal aural skills experiences on the most simple, subconscious level, other people engage deeply and consciously in these experiences as they have a higher proclivity than others to consume and participate in musical endeavor. A study from the 1990s supports the notion that the quality and frequency of previous experiences are significantly and positively connected with a student's success in aural skills. This study explored five variables emphasized in the search for predictors of music achievement: musical talent and aptitude, academic achievement, intelligence, musical experience, and motivation for music. Researchers tested students on ear training and sight singing tests and correlated these scores with survey and test results regarding the aforementioned five variables. Results of the study showed musical aptitude, academic ability, and musical experience significantly affect achievement in aural skills while motivation for music showed no statistical significance. The researchers hypothesize this could be attributed to the self-report of subject motivation leading to inaccurate correlative data. The findings of this study are important as musical aptitude, academic ability, and musical experience could all function as confounding variables in future research (Asmus, Harrison, & Serpe, 1994).

Unless students take an advanced music elective in high school or attend college as a music major, it is unlikely they will engage in formal aural skills training. Many researchers and teachers advocate changing this practice by requiring students to obtain fluency in basic aural skills concepts before reading music or using instruments to perform pitches and rhythms. A recent study supported this idea after testing beginning music students to find the effectiveness of utilizing a beginning music curriculum built upon aural skills fundamentals. This experimental study was conducted specifically to test the effectiveness of "tonal training" on the playing skills of beginning sixth grade wind instrumentalists. Tonal training was defined in this study as the use of vocalization and solfege syllables to emphasize sensitivity to pitch relationships. This study was conducted in an effort to solve the issue of students using their instruments as "tonal crutches" by associating written notation with correct fingerings rather than the correct sound. Analysis of the data collected in the experiment revealed that tonal training positively contributes to overall playing achievement without deterring the development of melodic sight reading ability (Benhard, 2004).

Ear Training Pedagogy

Traditionally, aural skills are taught in a progression that aligns with the order in which students learn music theory concepts. As such, aural skills students usually work first within the diatonic major scale, studying intervallic relationships and the function of chords within a tonal system. Using this knowledge as a basis, lessons expand from there, adding next altered tones from secondary dominant and mode mixture schemes. Using his own research and the findings of other research regarding aural skills acquisition and general cognitive processing, the writer and music educator Edward Klonoski advocates re-ordering the presentation of curricular aural skills concepts into a perceptually-based learning hierarchy for teaching beginning aural skills students. Klonoski begins his argument by mentioning the historical, vigorous resistance to change demonstrated by educators and theorists of aural skills pedagogy. This is significant as Klonoski projects music educators will resist changes to the traditional aural skills curriculum even though advances in cognition research on aural skills pedagogy suggest presenting aural skills concepts in the sequence that parallels music theory concepts is not cognitively ideal for the aural skills student. Though it is outside the scope of Klonoski's article, his point also is relevant to the use of technology in aural skills instruction as it can be challenging to implement new instructional strategies for both students and instructors, even if such strategies are supported by research. Regardless, in light of perceptual considerations, Klonoski recommends re-ordering aural skills such as interval training and chordal analysis to align with optimal perceptual sequencing for cognition rather than to conveniently align with the traditional progression of music theory concepts. By sequencing lessons and concepts in an informed, research-based progression, all students will receive logical, clear instruction and as such, possible confounding variables regarding cognitive processing and lesson design are controlled (Klonoski, 2000).

Bruce Benward is a renowned instructor and author of multiple aural skills and ear training texts. Benward also created a diagnostic laboratory in which his aural skills students were able to receive individualized instruction based on their own strengths and weaknesses regarding aural skills and general learning styles. Benward built exercises and programs for students who struggled to achieve certain aspects of aural skills such as defining rhythmic values or isolating the highest voice of a chord. Benward describes the use of interventional strategies such vocalization and requiring the student to complete an incomplete musical example. His commentary on the workings of his diagnostic laboratory is highly informative to the construction and consideration of lesson designs for all aural skills courses. Benward's insights are also applicable to technological aural skills programs as the instructor still must help students work through their own weaknesses and conceptual voids even if the student trains on a computer-assisted program. Benward argues that a successful diagnostic technique must be tailor-made to the individual, and in the context of the aural skills classroom, the instructor should always be aware of the individual needs of the student (Benward, 1968).

As the culmination of aural skills is the ability to transcribe and transmit music by ear, the activity of melodic dictation is a crucial centerpiece of the aural skills curriculum. Traditionally, dictation exercises are presented to students by an instructor who performs a melody on a single instrument, usually a piano, and the students are required to transcribe the melody by ear. In a more recent study regarding this specific activity, Edward Klonoski advocates changing the dictation process, urging instructors to teach critical listening skills such as tonal center identification, tonal memory, extractive listening, meter identification, and subvocalization before expecting students to participate with success in a melodic dictation exercise (Klonoski, 2006). Klonoski also recommends presenting melodic phrases with harmonic context rather than subjecting the student to an "interval by interval" melodic excerpt on a piano that does not represent any real composition. These claims echo previous research by Rosemary Killam who suggested students should learn to hear foreground events such as structural tendencies and tonal centers before learning to hear and combine specific intervals (Killam, 1984). By learning discrete, general listening skills before progressing to more traditional aural skills concepts such as specific intervals and formal counterpoint, the student will be able to more easily and instinctively transcribe melodies by ear.

The Process of Audiation

Dr. Edward Gordon is a researcher, author, and instructor of music education whose definition and study of the audiation process brought new insight to teaching ear training and aural skills. In short, audiation is the process that takes place when we hear and comprehend music for which the sound is no longer physically present (Gordon, 1994). Gordon defines the eight known types of audiation as well as the six theorized procedural steps by which each type of audiation is achieved. The eight types of audiation are: listening to music, reading music, writing music that is being heard, recalling music from memory, writing music from memory, performing as we create or improvise music, reading as we create or improvise music, and writing as we create or improvise music. The six stages of audiation are: momentary retention, imitating and audiating tonal and rhythmic patterns or identifying a tonal center and beat, establishing tonality and meter, retaining in audiation organized tonal and rhythm patterns, recalling patterns organized and audiated in other pieces of music, and finally, predicting patterns that will be heard next. Awareness of these stages allows an instructor to more effectively help students as the instructor can troubleshoot where the student is struggling within the systematic audiation process. Recognition of the types of audiation equips an instructor with the ability to create effective and varied audiation lessons and exercises. Gordon also suggests that musical aptitude and audiation are linked, meaning those who struggle to effectively audiate will also struggle to experience high levels of musical achievement. Gordon's insights are relevant as his research both presents the importance of teaching audiation and guides an aural skills instructor in designing an effective series of lessons. For the beginning student, the learning focus is on stages one and two of the audiation process: identifying tonal center and beats and imitating and audiating tonal and rhythm patterns.

A recent study published in *Music Educators Journal* by Hiatt and Cross provides further support for the implementation of audiation lessons within an aural skills curriculum. Guided by Gordon's research and insights, Hiatt and Cross advocate the use of "notational audiation" in which students actively relate music notation and audiated pitch through an aural, visual, vocal, and imaginative teacher-led process (Hiatt & Cross, 2006). The process is imaginative as students are asked to audiate pitches mentally before singing them aloud. This imaginative process could be especially useful when combined with Klonoski's technique of subvocalization. This process is highly valuable as many students struggle to connect their aural perception and visual comprehension of notation. Hiatt and Cross also describe applications of teaching audiation to applied instrumental students. Their recommendations support the significance and goals of teaching listening and singing as a part of audiation and aural skills training before teaching students to read notation or perfect instrumental technique. According to the authors of this article, as well as Gordon, students who learn first to audiate are more easily able to perform music with artistic sensitivity while demonstrating comprehension of complex musical elements such as tendency, cadence, and phrasing. This research further supports the significance of teaching all music students ear training and audiation techniques.

In defining audiation, Gordon notes that audiation is to music what thought is to speech (Gordon, 1994). Building upon that notion, Kathy Liperote draws a parallel between learning music and learning language in her study of utilizing audiation with beginning instrumentalists. As an applied instrumental instructor, she builds her program around these parallels of language and music, specifically listening, speaking, reading, and writing. She argues that when learning language, children listen for nearly a year before any speaking or writing vocabulary begins to emerge. By the same logic, she suggests that listening and speaking prepare musicians for reading and writing (Liperote, 2006). Again, this is contrary to traditional methods of teaching music that require students to immediately read and interpret visual notation with kinesthetic actions and aural pitch perception.

For beginning instrumentalists, Liperote advocates teaching songs by rote before teaching songs by visual notation. She includes a progression for teaching by rote which involves the students identifying and singing the tonal center as well as the teacher singing the roots of the harmonic progression while the students sing the melody. Echoing Gordon, Liperote supports requiring students to listen and sing before performing on instruments. Inclusion of the harmonic progression in the lesson also supports previous research claims by Klonoski and Killam that melodic information should be accompanied by harmonic context when presented to students. From the beginning of their instruction, or as soon as possible, Liperote recommends that students are enabled to express tonality and function during exercises in order to refine understanding of musical, structural tendency. For this reason, Liperote encourages the use of solfege or scale degree singing over singing letter names or neutral syllables such as “du” or “da.” Liperote provides compelling arguments for teaching listening concepts as a basis for all music education so reading and writing music can take place on a solid aural foundation (Liperote, 2016).

Computerized Technology as an Instructional Tool

Though computerized instructional programs have been used in music education since the mid 20th century, non-computerized, teacher-led instruction is still the most popular methodology for teaching aural skills and music theory. This is not due to a lack of existing computerized instructional programs as hundreds of programs have been developed in the last few decades to help students learn a variety of musical concepts on an electronic platform. Though lack of funding, lack of resources, distrust of computer-assisted methods, lack of teacher training, and familiarity with traditional, non-computerized strategies may all be factors in why computer-assisted technologies are not commonly used in the music classroom, these technologies offer unique experiences to students which could be beneficial to the aural skills learning process when implemented appropriately into the classroom (Nart, 2016).

A study conducted in 2000 provides extensive support for the use of computer-based technology in the classroom. Though the study does not pertain specifically to music, the researchers advocate the use of successful computer-based applications when implemented appropriately across all academic subjects, including the arts. Research is cited regarding case studies in which ordinary elementary students were able to learn college-level concepts of phrasing, figure, and meter by working with computer-based software at a center rotation in a classroom (Gordin, Hoadley, Means, Pea, & Roschelle, 2000). The researchers also describe specific implementations of computer-based applications in multiple subjects in which participating students are actively engaged, experience frequent interaction and feedback, and connect to real-world concepts. This article also provides recommendations on implementing computer-based technologies in instructional settings that have not previously utilized computer-based technology. This study suggests that use of computer-based software will positively impact students' aural skills achievement while also increasing student motivation. When using ear training software, students participate in an active experience in which they construct their own knowledge through frequent interaction with concepts and instant feedback from the program.

Computerized Technology in Music Education

Though technology has greatly evolved since the design of the first software for music education, the target learning concepts for music students have remained constant. Advances in graphic design, computer processing speed, Internet compatibility, computer hardware, and mobile technology have changed the layouts, usability, and aesthetic presentation of concepts by software, while research in cognitive processing and learning styles has changed the mode and order of how musical concepts are presented. The actual musical concepts of pitch, melody, rhythm, and harmony, are the same pieces of information now as they have always been (Nart, 2016).

One of the first music education software designs to achieve success in the classroom, the Graded Units for Interactive Dictation Operations (GUIDO) system, was developed in the 1970s as a competency based program which trained users on intervals, melodies, chords, harmonies, and rhythms. The program can be adjusted to serve skill levels ranging from novice young children to advanced collegiate music majors. One of the advantages of the system is the ability to analyze data about student progress and comprehension as all questions and answers are saved in a data base and can be reviewed by the instructor or the student himself or herself. This information made GUIDO crucial in research regarding the student perception of intervals, melodies, chords, harmonies, and rhythms. Through data analysis, researchers have been able to define multiple “confusion patterns” which can be combated by concept-specific interventions implemented on an individual basis by an instructor (Hofstetter, 1980). Though this study concerns antiquated technology, analysis of the GUIDO system is essential to the scope of this project as it was one of the first computer-based technologies that provided easily accessible data, controlled evaluation of methods, and a student-centered, competence-based progression of concepts. By comparing the results and data generated through GUIDO with results obtained on other systems, a collective model for aural skills instruction can continue to be developed.

An article by Berz and Bowman describes the entire history of computer-based technologies used in music education. This history is broken into four, chronological periods: development, mainframe, traditional computer-assisted instruction, and the current emerging technologies period. The cyclical nature of technological development for educational purposes is also a focus of this study. Berz and Bowman begin by describing the process of how new technology is developed then transferred to a practical work environment. Researchers then either extend the cycle by conducting research on the effectiveness of existing technology or begin a new cycle by participating in the development of new technology. The authors argue that not enough research is conducted on the pedagogical effects of existing music education technology (Berz & Bowman, 1995). In reference to that claim, Berz and Bowman recommend further research into the effectiveness of current emerging technologies such as holistic, curricular programs like Quaver and Practica Musica, as well as training software that can be accessed for free on an Internet domain. As this technology already exists and can accessed by anyone with Internet access, further research on the capability of this technology could prove important for instructors of beginning music students, especially those of low socioeconomic status.

A 2016 study by Sevan Nart aims to recognize, categorize, and analyze all software currently used and deemed to be beneficial in music education. Nart begins by noting the importance of using computer-assisted technology in the modern classroom as students of today are mostly all "digital natives," and as such, it is the instructor's duty to be fluent and competent with instructional technologies that will motivate students while allowing them to engage in an interactive, student-centered, instructional program (Nart, 2016). Nart makes recommendations of how to effectively implement these technologies in the conclusion of his study. Though some of the study relates specifically to incorporating music education technology on a national scale into the Turkish education system, this study is relevant outside of that nationalistic context as it includes a detailed and up to date analysis of many music education software programs available worldwide. In analysis, Nart breaks down the relevant music software into six categories: tutorial software, drill and practice software, game software, notation software, and sequencing/recording software. In application to teaching beginning aural skills, focus is given primarily to drill and practice software and secondarily to game software as these categories provide a meaningful, motivating, and interactive learning experience for learning basic aural skills concepts.

Computer-Assisted Aural Skills Instruction

Although Rosemary Killam's studies of computer-assisted instruction in aural skills were conducted thirty years ago while using antiquated technology, her findings, recommendations, and insights are still applicable when considering modern aural skills instruction using the latest computer-assisted technologies. As aural skills are a complex, hierarchical skill set, Killam argues, the order and mode of presenting these relationships and concepts to students is highly important, especially when teaching beginning aural skills students (Killam, 1984). After analyzing data collected from multiple tests, Killam suggests that students should first learn to hear and recognize foreground events and relationships such as the tonal center and structural points of dissonance and tendency before learning to hear individual components such as pitches, intervals, and rhythmic patterns. Because of this, Killam recommends using the ends of compositions when teaching beginning aural skills concepts, reasoning that it is at the end of compositions where the most explicit structural points of tendency are manifested. Killam also found that dividing a musical example into multiple, specific lessons of melody, harmony, and rhythm often makes a lesson more difficult than if the musical example was left as a musical whole with all melody, harmony, and rhythmic elements kept intact. Killam includes at the end of her study an outline of a specific lesson design that utilizes all of her theories, findings, and recommendations.

The activity of sight-reading music requires the participant to synthesize knowledge of pitch, rhythm, melodic contour, and harmonic context simultaneously. It also requires students to utilize aural skills such as intervallic relationships and harmonic tendency in reaction to interpreting the visual notation of music on a staff. Because of this, analyzing a study of the effects of technology on sight-reading skills is highly informative to constructing a study about the effects of technology on beginning aural skills concepts. One particular study from 2014 tested technology and non-technology classes, using a pre-test/post-test experimental design. During the treatment period, technology class participants received instruction using the 2012b version of SmartMusic software and a headset microphone while non-technology participants received traditional, instructor led instruction. The results of this study found that there was no significant difference between technology and non-technology classes in reference to sight-reading skills. One implication of these results is that even if technology is utilized in the classroom, direct instruction from the teacher is still a highly effective, crucial, and important teaching strategy. The researchers did find that a benefit of the use of technology is the feature of instantaneous feedback. They suggest that research should be conducted concerning the effectiveness of technology on aural skills acquisition and error detection skills (Henry & Petty, 2014). While sight-reading instruction is a complex, comprehensive task for a beginning choir student, basic aural skills concepts could be considered more easily definable and obtainable for beginning music students. As such, this study provides a supportive context for the testing of the effectiveness of technology on aural skills acquisition.

Conclusion

Recent research has supported the notion that excellence in fundamental aural skills positively correlates with a student's achievement in sight-reading visual notation, performing from memory, and improvising (Woody, 2012). These findings contradict the popular belief among music educators that playing by ear is a specialized skill with limited applications in a formal music classroom. Because formal music in the classroom is often turned into a purely visual to kinesthetic experience for the student performer, student musicians who are formally trained often learn to "read and express" before they learn to "listen and speak," to borrow terminology from Liperote. This is the problem to which I recommend music educators and researchers find the most efficient, effective solution.

One such possible solution could be the implementation of computer-assisted technology in aural skills instruction. Research supports the claim that the utilization of computer technology in the classroom increases active engagement in lessons, allows the student to receive quick and accurate feedback, and provides a platform through which the student can experience frequent interaction with skills and concepts (Gordin, Hoadley, Means, Pea, & Roschelle, 2000). Research also supports the notion that using computerized technology in the classroom increases student motivation.

Another solution could be re-ordering the presentation of aural skills concepts to students in a progression that is informed by recent findings regarding cognitive processing of aural skills concepts. In this sequence, foreground, listening-based events such as tonal center identification, tonal memory, extractive listening, and meter identification are presented first before working with more specific, beginning aural skills concepts such as chord and mode identification (Klonoski, 2006).

Combining both of these possible solutions is the focus of this study. Utilizing computerized, aural skills instructional technology while sequencing concepts in a progression that is informed by research regarding the best practices for ear training, the process of audiation, and the cognitive processing of aural skills will generate a beginning aural skills instructional plan that deviates from traditional plans and is likely to yield higher levels of student achievement in basic aural skills concepts.

Chapter 3

Methodology and Procedures

Recent research related to teaching aural skills indicates that certain computerized instructional programs could aid students in advancing and succeeding in ear training. Based on the review of literature regarding teaching aural skills and utilizing computer assisted technology in the classroom, research was conducted at a specific private arts instruction center to investigate the effects of computerized ear training on aural skills achievement. The purpose of this study was to provide research to support the best practices for teaching aural skills and to test the effects of one such computerized instructional system.

Population

The population for this study consisted of students at a private arts center in Northeast Tennessee. This center opened as a multi-disciplinary arts academy in 2006, and approximately 500 students take instruction in music, dance, and visual arts at the center each semester. Students range from pre-kindergarten to adult age, but most students are in grades K-12. Most of the population of students at the art center are white, but the population includes small percentages of African-American, Asian-American, Hispanic, and Native American students. In music lessons, the ratio of teachers to students is 1 to 1. In dance and visual arts lessons, the ratio is between 1 to 5 and 1 to 15, depending on the class. Classes meet in the afternoons on weekdays between 2 and 8 pm, and each teacher sees each of their students for one lesson per week. Most lessons last thirty minutes, though some advanced lessons last one hour. Though the socioeconomic status of the center's population is not officially registered, most students are supported by middle to high income families. A smaller percentage of the population of students come from low income families, and some of these students are able to apply for reduced tuition.

Sample

The sample for this study was drawn from the students of one particular teacher at the arts center who was also the primary researcher of this study. The participants were not randomly selected, as this sample represents an intact class of the teacher's weekly music students. The students were, however, randomly assigned to the experimental and control groups used in the study. The sample was composed of 20 students, and within the sample, 18 of the students were white, one was Asian, and one was Hispanic. Within the sample, 4 were percussion students, 7 were guitar students, and 9 were piano students. The gender division of the class included 15 males and 5 females. The age of the sample group ranged from 9 to 17 years old. The sample group served as both the control and the experimental groups for the study.

Data Collection Instruments

Two data collection instruments were used for this study. The first instrument was an ear training test used to measure advancement and achievement in aural skills. The test required students to identify each of the eleven intervals and three chords that comprised the focus of the study by ear. The test required students to listen to a combination of notes played by the teacher on the piano and then identify the combination of pitches as being the one of the eleven intervals or three chords from the study. Participants were seated so they could not see the piano or the teacher, forcing them to rely completely upon their ear training. Each of the intervals appeared twice during the test, and each of the chords appeared three times during the test, resulting in 31 total test items. Each participant was given the same form of the test so the presentation of intervals and chords occurred in the same order for every participant. The test was administered following an ear training course that utilized either computerized methods for the experimental group or non-computerized methods for the control group. Half of the participants were assigned randomly to the experimental group and the other half were assigned randomly to the control group.

The second instrument used was a survey which measured students' attitudes toward their experiences in the ear training course. This survey used a Likert scale and data was quantized as students responded by marking a value between 1 (strongly disagree) and 5 (strongly agree). After administering the survey and tests, all data were collected and analyzed.

Procedures

Before research began, permission to perform this study was obtained from the director of the arts center at which the study was conducted. Permission was also sought and obtained from Milligan College IRB. The guardians of each participant were addressed in person by the researcher who discussed the ear training program and the significance of learning aural skills. The researcher also distributed parental consent and participant assent forms which described in detail the study to be conducted. The parents and guardians were assured of the confidentiality of data and were given the option of participating or not without penalty.

Once consent and assent to participate in the study was received, participants were randomly divided into control and experimental groups with 10 students in each group. After this designation, the study was implemented. The students in both experimental and control groups participated in a five week aural skills instructional program. The participants in the experimental group were taught using computerized methods while the participants in the control group were taught using non-computerized methods. Each student met with the instructor for one thirty minute lesson per week. During the instruction of the experimental group participants, ten minutes of computerized instruction was utilized during this thirty minute period. In the instruction of the control group, no computerized instruction was used. At the end of this five week period, the ear training assessment was administered and data from the assessment were collected and analyzed. The survey was also administered to measure the attitudes of the students toward their experience in the study.

Research Questions and Hypotheses

Research Question 1: Is there a difference between aural skills assessment scores of students taught using computerized methods, and aural skills assessment scores when using non-computerized methods during instruction?

Research Hypothesis 1: There is a difference between aural skills assessment scores of students taught using computerized methods and students taught using non-computerized methods.

Null Hypothesis 1: There is no difference between aural skills assessment scores of students taught using computerized methods and students taught using non-computerized methods.

Research Question 2: Is there a difference in students attitudes when they are taught using computerized methods and when they are taught using non-computerized methods?

Research Hypothesis 2: There is a difference in students attitudes when they are taught using computerized methods and when they are taught using non-computerized methods.

Null Hypothesis 2: There is no difference in students attitudes when they are taught using computerized methods and when they are taught using non-computerized methods.

Chapter 4

Data Analysis

The purpose of this study was to examine the effects of computerized and traditional ear training methods on the test scores and attitudes of music students.

Data Collection

Data were collected from a sample of twenty music students. The participants were randomly assigned to one of two groups: the control group which experienced aural skills lessons taught using traditional ear training methods or the experimental group which experienced aural skills lessons taught using computerized ear training methods. Data were collected at the end of a five week instructional period to determine if there was a difference between the test scores and attitudes of the students in each of the two groups. At the end of the instructional period, each participant was given the same thirty-one question aural skills test and four question experience survey which utilized a Likert scale. All statistics were calculated with a .05 level of significance.

Research Questions and Related Hypotheses

Two research questions were formulated to determine the effects and potential benefits of computerized and traditional ear training methods.

Research Question 1: Is there a difference between aural skills assessment scores of students taught using computerized methods, and aural skills assessment scores when using non-computerized methods during instruction?

In response to research question 1, the mean test scores for both the control and experimental groups were calculated revealing the mean test score for the control group to be 20.1 and the mean score for the experimental group to be 26.2, giving a mean difference of 6.1.

The following research hypothesis was related to research question 1:

Research Hypothesis 1: There is a difference between aural skills assessment scores of students taught using computerized methods and students taught using non-computerized methods.

A t-test for independent samples was calculated to compare the ear training test scores of the control and experimental groups. Results indicated a t-value of ($t = -3.627$). The Levene's test for equality of variances P-value was more than .05, so the variances were assumed to be equal. The t-test for equality of means revealed a significant difference ($t(18) = -3.627$, $P < .05$). The effect size was 1.62. Therefore, the null hypothesis was rejected and it was stated with a 95% level of confidence that there was a significant difference between aural skills assessment scores of students taught using computerized methods and students taught using non-computerized methods during this study. The t-test results are shown below in Table 1.

Table 1

Independent Samples Test for Ear Training test scores

Group	M	Sd	df	T-value	Sig	Effect Size
Experimental	26.20	3.725	18	-3.627	.002	1.62
Control	20.10	3.795				

Research Question 2: Is there a difference in students attitudes when they are taught using computerized methods and when they are taught using non-computerized methods?

In response to research question 2, the mean attitude survey scores for both the control and experimental groups were calculated revealing the mean attitude survey score for the control group to be 17.0 and the mean score for the experimental group to be 15.9, resulting in a mean difference of 1.1.

The following research hypothesis was related to research question 2:

Research Hypothesis 2: There is a difference in students attitudes when they are taught using computerized methods and when they are taught using non-computerized methods.

A t-test for independent samples was calculated to compare the attitude survey scores of the control and experimental groups. Results indicated a t-value of (t= 1.071). The Levene's test for equality of variances P-value was more than .05, so the variances were assumed to be equal. The t-test for equality of means revealed no significant results (t (18) = 1.071, P>,05). Therefore, the null hypothesis was retained and it was stated with a 95% level of confidence that there was no significant difference between attitude survey scores of students taught using computerized methods and students taught using non-computerized methods during this study. The t-test results are displayed in Table 2.

Table 2

Independent Samples Test for attitude survey scores

Group	M	Sd	df	T-value	Sig
Experimental	15.90	2.283	18	1.071	.298
Control	20.10	3.795			

Chapter 5

Discussion

The purpose of this study was to determine the effects of computerized and traditional ear training methods on the aural skills abilities of elementary music students. This chapter includes a summary of findings, conclusions, recommendations, and implications.

Summary of Findings

In regards to research question one, which focused on the difference between the test scores of the experimental group students who used computerized technology and the test scores of control group students who did not use computerized technology during the ear training program, the mean scores of both groups were compared. Results indicated a significant difference between the test scores of the two groups ($t(18)=-3.627$, $P=.002$, $ES=1.62$). Analysis of the data collected revealed that, for this study, students who used computerized technology achieved significantly higher mean scores on the ear training test than students who did not use computerized technology. The large effect size of 1.62 indicates a high magnitude of difference between the test scores of the control and experimental groups. Students in the experimental group not only scored better on the ear training test, but were also observed to be able to more quickly and easily answer each test item compared to the control group students. The significant advantages demonstrated by the experimental group in this study are consistent with information presented in the literature review of this study. Students who are assisted in ear training by computer technology are likely to exhibit higher ear training test scores as well as increased comprehension of aural skills concepts (Gordin, Hoadley, Means, Pea, & Roschelle, 2000).

When research question two was examined, a comparison was made between the attitude scores of students who used computerized technology and the attitude scores of students who did not use computerized technology. Results indicated no significant difference between the two groups, and therefore, the null hypothesis was retained. These results suggest both experimental and control groups enjoyed the ear training program the same. However, the control group appeared to enjoy the program more than the experimental group as the reported attitude scores of the control group were slightly higher than the reported attitude scores of the experimental group. Still, this difference was not enough to be statistically significant. Considering the survey scores, the lack of significant difference between groups could be attributed to the instructor's aim to make the ear training program enjoyable for all participants, regardless of group assignment.

Conclusions

The purpose of this study was to determine the effects of computerized and traditional ear training methods on the aural skills abilities of elementary music students. Two research questions were addressed in this study. Research question one, which focused on the difference between the test scores of the experimental group students and the test scores of the control group students, found significant results. The experimental group that was exposed to computerized ear training methods scored higher than the control group that was taught using traditional, non-computerized methods. As such, the null hypothesis for research question one was rejected.

The results of research question two, which examined the attitudes of students when they were exposed to computerized and non-computerized ear training methods, indicated no significant difference. According to analysis of the results, both the experimental and control groups demonstrated attitudes about the ear training program that were relatively equivalent. Because of this, the null hypothesis for research question two was retained.

Recommendations

1. Further research should be conducted controlling for the variable of practice time. Though students in both groups were given methods and procedures for individual practice, this study did not collect the amount of time each student spent practicing outside of class.
2. Further research should focus on the effectiveness of computerized methods on other music skills. While this study only focused on aural skills, other studies could focus on the use of computerized technology to assist in sight reading, music theory, and other musical skill sets.
3. Further research should test the effectiveness of various computerized ear training programs. The program used in this study, located at www.musictheory.net, is one of many computerized music education programs. This study could be replicated using a different programs or test for a difference

of effectiveness between multiple programs.

Implications

1. Computerized educational software is a powerful tool that enables music students to more easily become autonomous in their practice and understanding of aural skills.
2. Teachers can utilize computerized instructional methods during classroom lessons and homework assignments to bolster the comprehension levels of aural skills students.
3. Parents of music students should encourage their students to use computerized ear training programs at home. Holding their students accountable to consistent practice on computerized programs will positively influence the aural skills abilities of students.

References

Asmus, E., Harrison, C., & Serpe, R. (1994). Effects of musical aptitude, academic ability, music experience, and motivation on aural skills, *Journal of Research in Music Education, 42*(2), 131-144. http://www.jstor.org/stable/3345497

Bernhard, H. (2004). The effects of tonal training on the melodic ear playing and sight reading achievement of beginning wind instrumentalists. *Contributions to Music Education, 31*(1), 91-107. http://www.jstor.org/stable/24133280

Benward, B. (1968). A diagnostic laboratory/sightsinging ear training. *American Music Teacher, 17*(3), 19-21. http://www.jstor.org/stable/43537203

Berz, W. & Bowman, J. (1995). A historical perspective on research cycles in music computer-based technology, *Bulletin of the Council for Research in Music Education, Fall*(126), 15-28. http://www.jstor.org/stable/40318731

Domek, R. (1979). Teaching aural skills to high school students. *Music educators journal, 65*(5), 54-57. Doi: http://www.jstor.org/stable/3395576

Gordin, D., Hoadley, C., Means, B., Pea, R., & Roschelle, J. (2000). Changing how and what children learn in school with computer-based technologies, *The Future of Children, 10*(2), 76-101. http://www.jstor.org/stable/1602690

Gordon, E. (1994). Audiation, the door to musical creativity. *Pastoral Music, December-January,* 39-41. http://www.jstor.org/stable/40375310

Henry, M. & Petty, C. (2014). The effects of technology on the sight-reading achievement of beginning choir students, *Texas Music Education Research, 2014*, 23-28. files.eric.ed.gov/fulltext/EJ1102254.pdf

Hiatt, J. & Cross, S. (2006). Teaching and using audiation in classroom instruction and applied lessons with advanced students, *Music Educators Journal, 92*(5), 46-49. http://www.jstor.org/stable/3878502

Hofstetter, F. (1980). Applications of the GUIDO system to aural skills research, *College Music Symposium, 21*(2), 46-53. http://www.jstor.org/stable/40374104

Killam, R. (1984). An effective computer-assisted learning environment for aural skill development. *Music Theory Spectrum, 6*, 52-62. http://www.jstor.org/stable/745802

Klonoski, E. (2000). A perceptual learning hierarchy: an imperative for aural skills pedagogy, *College Music Symposium, 40*, 168-169. http://www.jstor.org/stable/40374408

Klonoski, E. (2006). Improving dictation as an aural-skills instructional tool, *Music Educators Journal, 93*(1), 54-59. http://www.jstor.org/stable/3693431

Liperote, K. (2006). Audiation for beginning instrumentalists: listen, speak, read, write, *Music Educators Journal, 93*(1), 46-52. http://www.jstor.org/stable/3693430

Nart, S. (2016). Music software in the technology integrated music education. *The Turkish Online Journal of Educational Technology, 15*(2), 78-84. www.tojet.net/articles/v15i2/1529.pdf

Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2000). Changing how and what children learn in school with computer-based technologies. *The future of children, 10*(2), 76-101. Doi: http://www.jstor.org/stable/1602690

Rothgeb, J. (1981). Schenkerian theory: its implications for the undergraduate curriculum. *Music theory spectrum*, 3. Doi: http://www.jstor.org/stable/745802

Telesco, P. (1991). Contextual ear training. *Journal of music theory pedagogy*, *5*(2). Doi: http://www.miles.be/articles/28-contextual-ear-training

Woody, Robert. (2012). Playing by ear: foundation or frill, *Music Educators Journal, 99*(2), 82-88. http://www.jstor.org/stable/23364292