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

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A Paper Presented at the Annual Conference of the Mid-South Educational Research Association, Starkville, Mississippi, November 8- 10, 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

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.

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 his or her 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 were quantified 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.

Results

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.

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

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 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?

Each research question was followed by a research hypothesis. All research questions were analyzed using T-tests for independent means at .05 level of significance.

The first research question yielded significant results. The second research question did not yield significant results. The results are displayed in Tables 1, and, 2 respectively.

Table 1

Independent Samples Test for Ear Training test scores

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

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			

Discussion

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.

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