UNIVERSITY OF ALBERTA

A COMPARISON OF THE EFFECTS OF COMPUTER-BASED INTERACTIVE VERSUS NON-INTERACTIVE AUDIO ON THE SKILLS AND ATTITUDES OF MUSIC STUDENTS IN IDENTIFYING HARMONIC VOICING

BY

TRENT WORTHINGTON

A THESIS SUBMITTED TO THE DEPARTMENT OF ADULT, CAREER AND TECHNOLOGY EDUCATION IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled A COMPARISON OF THE EFFECTS OF COMPUTER-BASED INTERACTIVE VERSUS NON-INTERACTIVE AUDIO ON THE SKILLS AND ATTITUDES OF MUSIC STUDENTS IN IDENTIFYING HARMONIC VOICING submitted by TRENT WORTHINGTON in partial fulfillment of the requirements for the degree of MASTER OF EDUCATION in INSTRUCTIONAL TECHNOLOGY.

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Abstract

Comparing the effects of interactive audio in CBI versus non-interactive audio in CBI on the skills and attitudes of music students in identifying harmonic voicing has been divided into two sub-problems for the purposes of this study. The first sub-problem is to compare music students' skill in identifying harmonic voicing using interactive versus non-interactive audio. The second sub-problem is to compare music students' attitude toward CBI using interactive versus non-interactive audio.

A two group pretest-posttest experiment was conducted in which forty-six participants volunteered to work with a computer program developed for this study; the experimental group used interactive audio and the control group used non-interactive audio; and, both groups completed an attitude measure. The test scores showed acceptable to high reliability. Analysis of the data revealed that the experimental group showed greater skill development than the control group in identifying harmonic voicing. Analysis of the attitudinal measurement revealed no difference between the groups.

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Introduction

The following thesis is submitted in partial fulfillment of the requirements for the degree of Master of Education in Instructional Technology. The subject area of study is aural skills training in music. Although music and music education may initially appear to be quite self-contained without the need for technology, modern technology can be very valuable to both the modern musician and the music teacher. The study follows much research in the area of Computer-Based Instruction (CBI) and aural skills, however the specific topic of study is not documented in the existing body of literature on the subject and therefore will contribute new information to the field.

Statement of the Problem

Chapter Introduction

The musician in ensemble performance is typically surrounded by harmony. A good performance is partially dependent upon proper relationships among voices. Effective harmonic analysis provides the foundation for understanding the interrelationships between voice parts: identification of individual voices which make up the vertical harmonic structure requires abilities in listening and analysis. Woodrulff & Heeler (1991) state that listening defines a musical experience. Aural skills need to be developed in order for musicians to experience music more completely. Given that involving the student in interactive dialog during analysis can help form better listeners and better musicians (Pogonowski, 1989) and that computer technology with multimedia has been successfully applied in music education (Ashley, 1989; Gillespie & Placek, 1991; Kuzmich, 1989; Woodrulff & Heeler, 1990, 1991), CBI in aural skills with multimedia presentation in an interactive environment may lead to increased student abilities in harmonic analysis. This study will identify the value of having the music student use CBI with interactive audio for harmonic analysis. Interactive audio in this context refers to audible samples of three part harmonies utilizing student control of individual voice volume.

Problem

To compare the effects of interactive audio in CBI versus non-interactive audio in CBI on the skills and attitudes of music students in identifying harmonic voicing.

Sub-Problems

To compare music students' skill development in identifying harmonic voicing using interactive audio in CBI with those using non-interactive audio in CBI.

To compare music students' attitudes toward CBI in aural skills and interactive audio with those toward CBI in aural skills and non-interactive audio.

Limitations

The sample was a volunteer sample from an accessible population of university music students currently studying aural skills. These students may not be representative of all other university music students and therefore the generalizability of results may be limited.

A non-commercial computer program developed specifically for the experiment was used to deliver the lesson and gather data.

All participants completed the pretest, experimental treatment, posttest and attitude survey in only one session, lasting approximately one hour, on the same equipment.

Delimitations

The study included university music and music education students studying first and second year aural skills.

The study used one CBI software application engineered to include interactive and non-interactive audio.

The study included musical content consisting of differentiation of major, minor and diminished triads.

Definitions

Attitude:

measurement of student opinion toward CBI using a Likert-type instrument (Dr. M. Szabo, personal communication, November 21, 1991).

Aural skills:

abilities to identify parts and characteristics of musical sounds such as rhythm, intervals, chords, melody, harmony, dynamics, form, and timbre.

Computer-Based Instruction (CBI):

instruction which is generated and monitored by computer and delivered to students

Harmonic Voicing:

individual notes which combine to form harmonic structure - specifically, three notes of a major, minor or diminished triad.

Interactive Audio:

audible samples of harmonic voicing delivered by computer utilizing user control of individual voice volume.

Interactivity:

the interface between the student and the computer, involving control of audio.

Non-interactive Audio:

audible samples of harmonic voicing delivered by computer utilizing computer control of individual voice volume.

Assumptions

Because the participants will be enrolled in an aural skills course, it is assumed that each participant, while having the ability to hear sound, will also have a developed ability to hear music.

Need for Study

CBI in aural skills has been researched since the 1970's. Hofstetter pioneered the research supporting CBI using the PLATO system with a program called GUIDO (Hofstetter, 1975, 1979). Taylor (1982) evaluated computerized melodic dictation using PLATO and a program called MEDICI. He recommended that MEDICI be used at the university level of study and suggested further developments for CBI in aural skills. Interactive audio in computer-based aural skills instruction has not been thoroughly documented: GUIDO allowed student control of individual voices (Arenson & Hofstetter, 1983) but the effectiveness of this interactivity was never evaluated. Woodrulff & Heeler (1990, 1991) and Ashley (1989) successfully used interactive audio with videodisk and CD-ROM technology to develop listening skills of music students. Continued development of CBI in music on personal computers is supported (Blombach, 1989); and, in other disciplines, the use of interactive audio generates a better potential for learning (Fons & Zhang, 1991), therefore, the application of interactive audio to computer-based aural skills instruction may result in increased learning by aural skills students.

Chapter Summary

There is a need for further study in the area of CBI in music instruction, specifically in aural skills. As new technology becomes available, increasingly sophisticated tools become available to aid in music instruction. Interactive computer-based music instruction is a relatively new area with great potential and promise.

The need for study has been identified, and chapter one includes a description of the problem for study. Chapter two provides a review of related literature which will aid in placing the present study in context. Following the literature review is a chapter on the methodology of the study. Chapter four presents the results of the experiment. Finally, chapter five contains a summary of the study, conclusions drawn from the study, and recommendations for further study.

Review of Related Literature

Chapter Introduction

The study of CBI and interactive audio for identification of harmonic voicing is original, and previous research using CBI for aural skills suggests that continuation of research is warranted. Interactive audio in this context refers to student control over specific parameters of audible music such as ensemble balance and voice volume. Identification of harmonic voicing is closely related to harmonic dictation and is one of many fundamental aural skills. Aural skills remain an important foundation for musicians. The term refers to skill in recognition or identification of various components of music. Some of these components are: intervals, melodies, chords, harmonies, rhythms, timbres, and dynamics. Listening for all these components at the same time is very complicated (Madsen & Geringer, 1990) and therefore either very sophisticated measurement is necessary, or individual components should be used for training and evaluation. Studies in aural skills, both with and without computer aid, have looked at many of these individual components.

Computer-Based Instruction

A wealth of literature exists which shows the merits of using CBI in education. CBI can offer individualized instruction. Bloom (1984) describes methods of instruction and concludes that individualized instruction, specifically one-to-one tutoring, results in the greatest improvement in achievement. Kulik, Kulik and Cohen (1980) conclusively show that the use of CBI results in increased achievement. By the mid 1970's main-frame computers were supporting aural skills training programs (Hofstetter, 1975), and research was indicating positive results of CBI in music. As the microcomputer gained popularity, mainframe domination began a decline, along with the sophisticated programs for CBI in aural skills.

Although the use of microcomputers has extended into CBI, there is a noticeable lack of research in aural skills training using microcomputers. Only the recent availability of hardware resources for microcomputers which begin to rival those of the mainframe in terms of speed and capacity has led to more sophisticated programs in music education like Practicum Musica (Ars Nova, 1992) and MiBac Music Lessons (MiBac, 1992). As has been the case since mainframe domination, the computer and associated resources provide an ideal way to cost effectively train and evaluate students individually in aural skills.

Research in aural skills includes much from the time of the mainframe. Studies from the late 1970's provide insights into programs which have yet to be rivaled on microcomputers. The capability of the computer (mainframe and micro) to generate and play music provides a means for aural skills training on an individual basis without the costs and difficulties of human tutoring or individualized classroom instruction.

Aural Skills and CBI

One program for aural skills training is the source for some of the pioneering research in this area. GUIDO is a system which was developed beginning in 1974 for operation on a PLATO main-frame (Hofstetter, 1975, 1981; Arenson & Hofstetter, 1983). GUIDO offers training in aural skills and includes programs dealing with intervals, melodies, chords, harmonies, and rhythms. In 1975, Hofstetter published the first paper on GUIDO which was followed by a series of four studies all of which supported the use of CBI for aural skills training (Hofstetter, 1978, 1979, 1980, 1981) and recommended further study in the area.

In addition to the studies by Hofstetter, other research supports the use of CBI in aural skills. Canelos, Murphy, Blombach and Heck (1980) evaluated mastery learning, linear instruction and self-practice as methods for teaching interval identification. Their results show that mastery learning and linear instruction (both CBI) are superior to the traditional method in terms of achievement. Other studies compared CBI competency based learning of aural skills to traditional methods (Arenson, 1982; Greenfield & Codding, 1985) and found significant differences in achievement in favour of CBI. Arenson, although showing very significant findings, does not account for the influence of several confounding variables and his conclusions supporting CBI therefore seem weak. Another study on CBI in aural skills was done using MEDICI, a system developed in 1980 for operation on a PLATO main-frame (Newcomb, Weage and Spencer, 1981; Taylor, 1982). Taylor found no difference in achievement between CBI and traditional instruction in melodic dictation, however CBI proved to be more efficient and was recommended for further use. A more recent study comparing CBI and traditional instruction in music education was done by Bailey (1989) and similar results were found: CBI in music results in higher achievement.

Attitudes Towards CBI and Aural Skills

Many studies, in addition to evaluation of achievement, also include attitudinal surveys. The majority of studies dealing with CBI and aural skills report that students have positive attitudes toward CBI in music: students show increased interest, enthusiasm and motivation in music studies (Canelos, Murphy, Blombach & Heck, 1980; Clarkson & Pegley, 1991; Gross & Griffin, 1982; Hoffman, 1991; Hofstetter, 1979; Upitis, 1982; Weintraub, 1991). One study reported that no change in attitude occurred during the experiment (Humphries, 1980), however, the study does not indicate if the attitudes toward CBI in aural skills were positive or negative.

A notable exception identifies a majority of students who indicate that they felt CBI lessons in aural skills were too time consuming (Greenfield and Codding, 1985). These findings are supported by Pembrook (1986) who found that the majority of students who had used MEDICI reported a negative experience. Positive comments were made regarding the difficulty level of content, individualization, schedule flexibility, immediate grading and positive feedback, however the majority of students complained about the time commitment needed for CBI.

The majority of attitudinal surveys report general positive attitude toward CBI although some exceptions exist. Generally, student attitude seems to favour CBI in music aural skills.

Since much research points to the conclusion that CBI is effective and efficient, subsequent research has not bothered with the comparison of CBI and traditional instruction but instead has concentrated on variables within the CBI environment. Time spent at the computer and the relationship to achievement was a topic identified early in the development of CBI in music.

Practice Time at the Computer

A key study by Humphries (1980) is a cornerstone from which subsequent research has been founded. Humphries discovered that drill time has a definite correlation to achievement in interval identification. Although no optimum drill time was found, Humphries concluded that increased drill time results in increased achievement. These findings are corroborated by Gross and Griffin (1982) who found that for atomistic problems, more time at the computer resulted in increased achievement. Pembrook (1986) made a similar observation regarding rehearing of a melodic sample: students who listened to the sample two or three times were able to notate it better than students who listened only once.

Notation of melodic samples as researched by Pembrook (1986) begins to focus on the narrower topic at hand. The foundation for CBI in music has been laid, and practice time has been identified as important for achievement; recent studies have shown that listening and notation skills can be developed successfully with CBI.

Listening and Notating

Sink (1983) hypothesized that the complexities of melody and rhythm interfere with one another during listening exercises dealing with only one (either melody or rhythm). This problem was echoed by Madsen and Geringer (1990) who suggest that listening occurs selectively, and that several components of music can be confounding to the listener when concentration is demanded on only one component. Doing research on listening abilities, Dalby (1989) discovered that CBI results in increased abilities for harmonic discrimination. These studies (Sink, 1983; Madsen & Geringer, 1990; Dalby, 1989) indicate that CBI can be used to create a better environment for listening and notating. Although this statement could have been hypothesized from the early research using GUIDO, these studies have provided experimental evidence to suggest that this is true.

Harmonic Dictation

Listening and notation skills are linked to a musician's success not only in knowledge and theory but also in performance. Humphreys (1986) did research with music teachers to determine methods of training, measuring and predicting abilities in harmonic audiation (listening skills). He found that a strong relationship exists between notating and performing harmony. Since much of the musicians life is devoted to performance, research like Humphreys' study provides insight into the training which should occur for music students. Harmonic dictation is a skill which combines knowledge of chords, melody, harmony, rhythm, and notation; however, research on the development of this skill is not abundant.

Identification of harmonic voicing is fundamental in harmonic dictation. Much of CBI in dictation has been melodic (GUIDO and MEDICI), although other skills such as chord analysis and interval identification which are also supported by GUIDO are closely related to harmonic dictation. Harmonic applications in CBI have shown positive results with relation to both notation and performance. This accumulation of previous research paves the way for study of CBI in harmonic dictation. GUIDO allows student control of voice volume during melodic dictation (Arenson & Hofstetter, 1983), although no data has been collected to determine the effectiveness of this technique. The same principle applied to identification of harmonic voicing in harmonic dictation may prove effective.

Interactive Multimedia

Woodrulff and Heeler (1990) compared the use of CBI and interactive videodisk versus CBI and no videodisk. In the study, video capabilities were not used: at the time of the study videodisk technology was simply more accessible than CD-ROM technology, and therefore was used as an audio source. The study showed increased achievement as a result of interactive CBI. Where previous studies usually compared CBI with traditional instruction, Woodrulff and Heeler compared two groups which both use CBI, differing only in terms of interactivity. Ashley (1989) used CD-ROM technology for developing listening skills in music students. The study reported that interactive CD-ROM was effective in honing listening skills with respect to rhythm, harmony, melody, form and timbre. These studies (Ashley, 1989; Woodrulff & Heeler, 1990) support further research into interactive applications in computer-based music instruction. With regard to interactivity, Taylor (1988) commented that "students will become more involved when they can interact with their learning environment in interesting and different ways, and they will also have the opportunity to be creative in their personal approaches to learning" (p. 54).

Chapter Summary

CBI in aural skills has been effective both in terms of achievement and student attitude. A great deal of research has compared the effects of CBI with traditional instruction: results support the use of CBI. Newcomb (1988) summarizes and supports CBI in music:

> How are we doing in computer-based music instruction? We have made a beginning. The vineyard is large, the workers are few, and budgets are small. The work is fascinating. Public interest is growing, and the long-term outlook is partly sunny. (p.49)

Although harmonic dictation, or more specifically the identification of harmonic voices, has not been studied thoroughly, CBI in closely related areas, such as chord analysis and interval identification, has been implemented on programs such as GUIDO. Studies using CD-ROM and videodisk technology suggest that interactivity is effective and suggest that further research be carried out. Continuation of CBI applications in music is warranted and less developed areas such as harmonic voice identification, which have not been well documented, should be studied. This recommendation combined with the support for interactive CBI prepare sufficient groundwork for this study.

Methodology

Chapter Introduction

The use of the computer in music education is not a new idea. Previous studies of the application of computer based instruction in different applications to music education have used the resources of the computer to generate sounds, provide information, ask questions, and capture responses. Hofstetter (1979) used a two-group design to examine a competency based approach to teaching aural interval identification, and in 1990, Woodrulff & Heeler used a two-group design to test the effect of interactive videodisk in CBI. The following chapter outlines a methodology for experimentation to determine what effect interactive audio has upon the abilities of music students in identifying harmonic voicing.

Restatement of the Problem

To compare the effects of interactive audio in CBI versus non-interactive audio in CBI on the skills and attitudes of music students in identifying harmonic voicing.

Sub-Problems

To compare music students' skill development in identifying harmonic voicing using interactive audio in CBI with those using non-interactive audio in CBI.

To compare music students' attitudes toward CBI in aural skills and interactive audio with those toward CBI in aural skills and non-interactive audio.

Sample

Subjects for the study were music and music education students at the university level of study in winter term 1992/93. At the time of the study, the participants were enrolled in first year or second year aural skills training, or had recently completed such a course. Participation in the study was on a voluntary basis and participants had the option to cease participation in the study at any time. Approximately ninety-five students were eligible for the study and forty-six volunteered to participate.

Instrumentation

The CBI Lesson

A computer program in four parts developed with Authorware Professional © version 1.7 for Macintosh was used to deliver the lesson and collect data (please refer to the thesis pocket for a copy of the software).

The four parts of the computer program are described below. Although the modules are each self-contained executable programs, they are transparently linked together in one seamless presentation.

The first part of the program is a pretest of abilities in aural skills (see Appendix B for a hard copy of the measurement items). Using triad samples prepared for audible computer delivery, the user identifies the quality of each triad as major, minor or diminished. To facilitate a two-group experimental design, there are two versions of this module: Module-One which links to Module-Two (using non-interactive audio) and Module-One-i which links to Module-Two-i (using interactive audio).

The second part of the program is a lesson in identification of triad quality (major, minor and diminished). Both versions of this module link to Module-Three.

The third part of the program is a posttest of abilities in aural skill, similar to the pretest in construction and content (see Appendix B for a hard copy of the measurement items). Although the questions in the posttest are identical in structure to the questions in the pretest, the posttest uses different audible samples. This module links to Module-Four.

Finally, the fourth part is a Likert-type survey of opinion toward CBI in aural skills (see Appendix B for a hard copy of the measurement items). The attitude survey is based on an instrument to measure opinion toward CBI from M. Szabo (personal communication, March 24, 1992). The instrument categorizes student responses into five sub-areas and a total. Each score in the sub-areas represents the relative positive attitude the student has toward CBI in aural skills.

The modules write all participant data to unique external files (see Appendix C for a file listing of the raw data totals gathered in this study). A file of all responses and calculated totals called "MassData" is created in the same location as the RunAPM file which is used to run the modules. The record layout of the file is shown in Table 1.

Table 1.

MassData record layout

Column 1 - group ID(1 or 2)
Column 2-21 - pretest answers (1, 2, 3, or 4)
Column 22-41 - posttest answers (1, 2, 3, or 4)
Column 42-83 - attitude responses (1, 2, 3, 4, or 5)

Following column 83 is a TAB delimited series of numbers:

Pretest total out of 20
Listen again number of times the user asked to re-hear a music sample
Volume control number of times the user adjusted the volumes of voices
Posttest total out of 20
Attitude category A total out of 70
Attitude category B total out of 30
Attitude category C total out of 65
Attitude category D total out of 20
Attitude category E total out of 25
Attitude total total out of 210

In addition a file called "Comment File" is created in the same location and contains any user comments which were anonymously logged during the session.

The program was validated by content experts in aural skills. The supervisor of aural skills in the music department provided content information during the construction of the program, made revisions and subsequently approved the program following completion. In addition, a music education faculty member made revisions to the program during development and subsequently offered approval. The program was also validated by an instructional design expert who made revisions and provided subsequent approval.

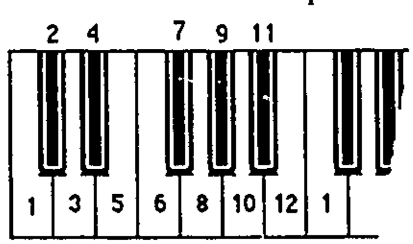
Terminology

A brief explanation of the musical terminology and symbols used is included here in order to add clarification to any subsequent musical references. During the computer session the students were asked to identify the chord quality of audible triads. Only major, minor and diminished chord qualities were used. It is important to recognize that musical theory is not the focus of the study, but rather the aural discrimination of differences in the chord qualities. Therefore, for the purposes of this document, the theory is explained in a manner suitable for understanding the aural significance of the task and not in a manner typically found in standard musical references.

A triad is a combination of three notes, typically spaced in intervals of thirds, which form a chord. There are two types of thirds: major and minor, where a major third is an interval of four semitones and a minor third is an interval of three semitones. The entire harmonic structure of music in the western world is based on a scale of twelve semitones where a semitone is the distance (in frequency) between notes. Figure 1 shows the repeating scale of semitones on the familiar piano keyboard.

Figure 1.

Twelve-tone scale on piano



A minor third would be an interval from note 1 to note 4 (a difference of three semitones), and a major third would be an interval from note 1 to note 5 (a difference of four semitones). Similarly, another minor third would be an interval from note 5 to note 8, and a major third from note 5 to note 9, and so on. Each interval is relative to the lower note.

A major triad is formed from a major third and a minor third. For example, a major triad could be formed from note 1 and note 5 (major third) and note 8 (a minor third from note 5).

A minor triad is formed from a minor third and a major third. For example, a minor triad could be formed from note 1 and note 4 (minor third) and note 8 (a major third from note 4).

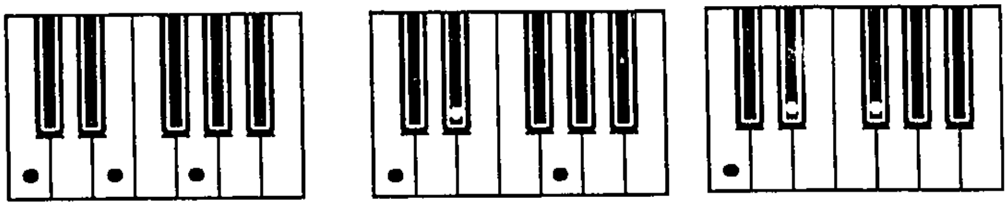
A diminished triad is formed from two minor thirds. For example, a diminished triad could be formed from note 1 and note 4 (minor third) and note 7 (a minor third from note 4).

Similarly, triads can be formed from any starting note as long as the intervals remain relative. For example, a major triad could be formed starting on note 3 and would consist of note 3, note 7, and note 10. A minor triad could also be formed starting on note 3 and would consist of note 3, note 6 and note 10. A diminished triad could be formed starting on note 3 and would consist of note 3, note 6 and note 9.

The students are required to differentiate aurally between these three types of qualities of triads. The differences are visually summarized in figure 2.

Figure 2.

Major, minor and diminished triads on piano



Engineering

Authorware Professional 1.7 for Macintosh was used to develop the program. This platform was chosen because of the familiarity the aural skills students had with Macintosh computers from use in the aural skills course. Two customized features were used with Authorware Professional: an external command (XFCN) was built to play the triads and a modified version of the RunAPM file was used to deliver the program.

External Command

A program called SndCmd XFCN was developed for this study by members of the Apple Research Partnership Program (ARPP). SndCmd XFCN uses control parameters to generate wave patterns at defined frequencies using the internal tone-generators in the Macintosh. SndCmd functions only under system 7. The XFCN is included in the Authorware modules found in the thesis pocket and user documentation is found in Appendix D.

Modified Run APM

The "return" icon used in Run APM version 1.7A.1 was modified to match the arrow icons used in the program.

Implementation

The program was installed in a read-only shared folder on a Macintosh IIsi server running system 7. The program files remained hidden from the users: access to the program was accomplished using system 7 aliases available on a network via a password. Participants used Macintosh IIci computers with 5 MB RAM running system 7 to access the network and run the program (see Appendix A for the user startup instructions). A hidden write-only data folder was created on the server in which all data from each participant was recorded (see Appendix C for a file listing of the raw data totals).

Procedures

Aural skills students were approached by the researcher during class in fall term 1992 and informed about the study and their potential involvement. Individuals participated voluntarily without coercion and retained the option of withdrawing from the study. In random order, each student received a copy of the user startup instructions with either the control group password or the experimental group password (see Appendix A). The participants accessed a CBI lesson from a lab of networked microcomputers. At the computer, the participants completed the pretest, progressed through the lesson at individual rates, and completed a posttest and attitude survey. The session time for each participant was approximately one hour.

The experiment was structured as a pretest-posttest control group design. Each participant was randomly assigned to either the control group or the treatment group. Although both groups used the same program, the experimental group (interactive audio) had control over individual voice volumes in the audio component; whereas, the control group used computer-controlled voice volumes in the audio component. All participants were able to hear the audible samples multiple times upon request. As the participants progressed through the sequence of the program, relevant data were recorded in an external file.

Anonymity of each participant was guaranteed as the names were not recorded, only a random identification number which indicates if the student was in the control group or the experimental group.

Chapter Summary

The sample used in the study volunteered from an accessible population of music and music education students at the university level and this limits the study to a quasi-experimental nature. However, the design of the study is theoretically sound and has been used before in the study of CBI in aural skills. At the heart of the study is the computer program which was developed carefully with input from both instructional designers and content experts.

Results

The following results are reported in two sections according to the two sub-problems in the study. The data were imported into computer programs for analysis. Excel 3.0, a spreadsheet program, was used to format the data and graphically represent relationships. Reliabilities were calculated with a statistical package called LERTAP, an item analysis program. In order to test for relationships within the data, SPSS^{X}4.0 was used for an analysis of variance (ANOVA) and subsequent contrasts. The ANOVA is robust with respect to violation of assumptions regarding its mathematical derivation (Kirk, 1968), and the ANOVA is appropriate for use in a two-group study (Winer, 1971).

The First Sub-problem

Data

To determine skill development in identifying harmonic voicing, individual scores on the aural harmony pretest and posttest were tabulated. The numbers are raw scores out of twenty, each set corresponding to one individual from either the experimental or control group. Summaries of these scores can be found in Table 2 and Figure 3.

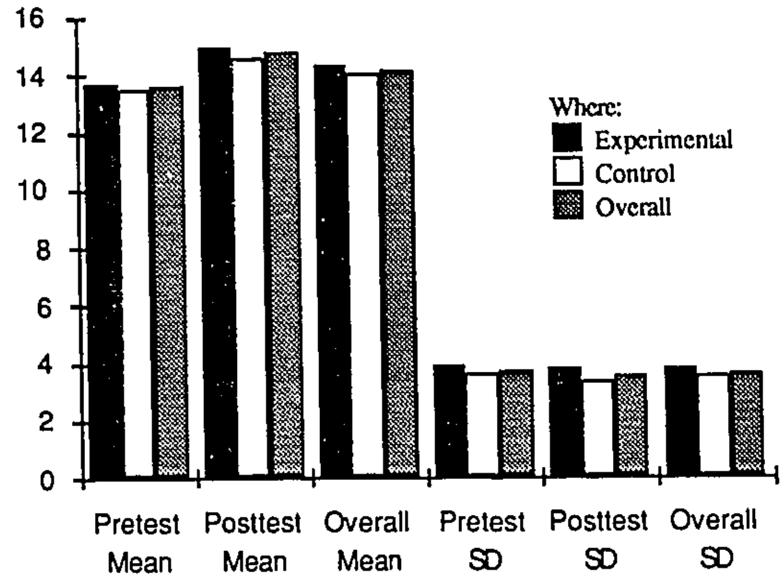
Table 2.

Test scores of identification of harmonic voicing.

	n	Pretest Mean	Posttest Mean	Overall Mean	Pretest SD	Posttest SD	Overall SD
Experimental	22	13.6	14.9	14.3	3.9	3.8	3.8
Control	24	13.5	14.5	14.0	3.6	3.3	3.5
All Subjects	46	13.5	14.7	14.1	3.7	3.5	3.6

Figure 3.

Test scores of identification of harmonic voicing



Analysis

Reliability.

Coefficient alpha was 0.72 for the twenty item pretest indicating that the test was internally consistent and reliable. The posttest was structured identical to the pretest, however the audible samples were different and the correct responses therefore were also different. Coefficient alpha for the twenty item posttest was 0.72. The reliability coefficients are the same, however differences exist between the tests allowing greater confidence in comparing the two tests.

Table 3.

Reliability coefficients for test scores

Measure	Alpha
Pretest	0.72
Posttest	0.72
Attitude	0.92 (0.81)*
Category A	0.76
Category B	0.79
Category C	0.84
Category D	0.70
Category E	0.79

* Cronbach's stratified alpha coefficient is shown in parenthesis

Main effect.

An ANOVA model was used in a 2 (group) X 2 (Time: pretest vs. posttest) analysis of variance with repeated measures on the last variable (see Table 4). Analysis revealed no difference between the experimental group and the control group overall: $F(1,44) = .07$, $p = .79$. Analysis revealed a significant difference overall within the groups between the pretest and the posttest: $F(1,44) = 15.91$, $p < .05$.

Interaction.

Analysis revealed no interactive effect between the groups: $F(1,44) = .10$, $p = .75$ (the interactive effect is shown in figure 4).

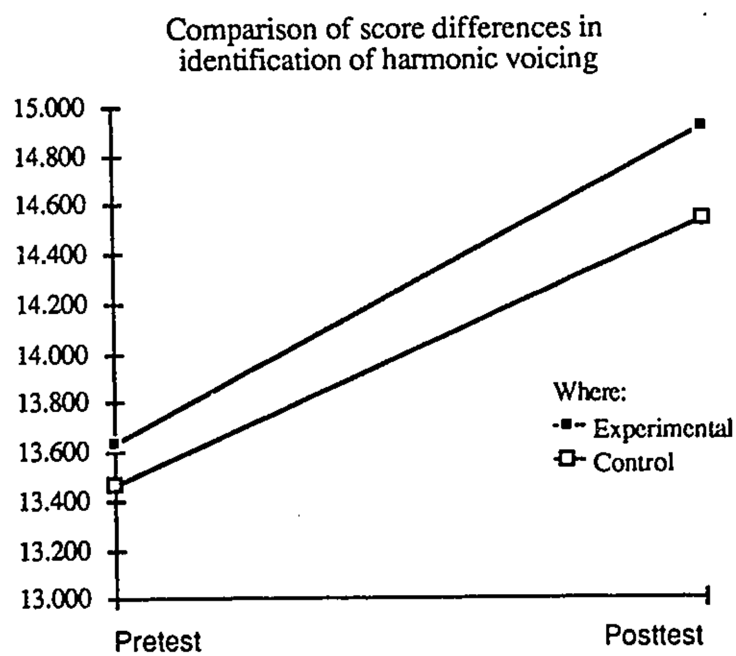
Table 4.

ANOVA of group X time (pretest vs. posttest)

Source	df	MS	F
Between Subjects			
Group	1	1.71	.07
Error	44	24.61	
Within Subjects			
Time	1	31.86	15.91*
Group X Time	1	.21	.10
Error	44	2.00	

* $\underline{p} < .05$

Figure 4.



Contrast.

A Scheffé contrast showed the experimental group differed between the pretest and the posttest: $F(1,44) = 2.98$, $p < .05$; the control group effect across the pretest and posttest was negligible: $F(1,44) = 2.65$, $p = .11$.

Conclusion.

The between-group-effect was negligible ($p > .05$), indicating that no differences existed between the control group and the experimental group overall (collapsed across the tests), however the significant within-group-effect ($p \leq .05$) between the pretest and the posttest showed that there is a difference in the overall achievement scores between the two tests (collapsed across the groups). Where the ANOVA model uses the overall scores for analysis, the Scheffé contrast does not collapse across the groups and therefore can attribute the difference noted in the ANOVA to a specific source: in this case, a difference when contrasting the pretest and posttest scores of each group (Table 5 summarizes the relationships between the statistical tests). The contrast showed a difference between the pretest and posttest scores of the experimental group but not the control group. Relative to the first sub-problem, interactive audio resulted in better skill development in identifying harmonic voicing than non-interactive audio.

Table 5.

Relationship of statistical tests

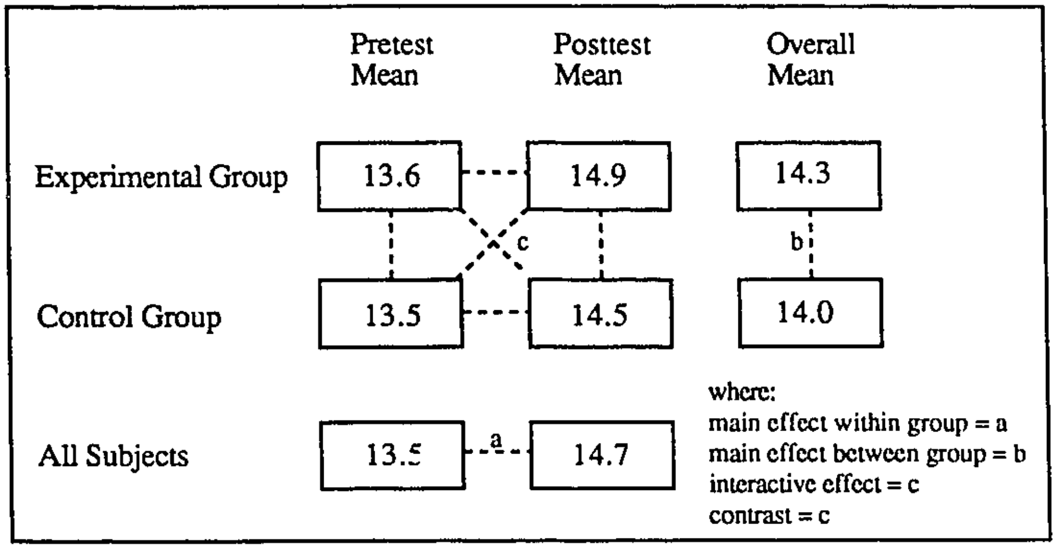


Table 6.

Positive attitudes toward CBI in aural skills

Mean Values:	n	Cat A	Cat B	Cat C	Cat D	Cat E	Total
Experimental	22	46.6	20.7	43.0	14.6	16.4	141.4
Control	24	47.3	17.1	43.0	14.2	16.0	137.7
All Subjects	46	47.0	18.8	43.0	14.4	16.2	139.4

SD Values:	n	Cat A	Cat B	Cat C	Cat D	Cat E	Total
Experimental	22	5.6	2.5	5.3	2.4	2.8	14.6
Control	24	6.5	4.0	7.0	2.5	3.3	19.4
All Subjects	46	6.0	3.8	6.1	2.5	3.0	17.2

where: Cat.A-instructional strategy, Cat.B-personalization of CAI, Cat.C-individual reaction, Cat.D-interest in subject matter, Cat.E-technical operation of equipment

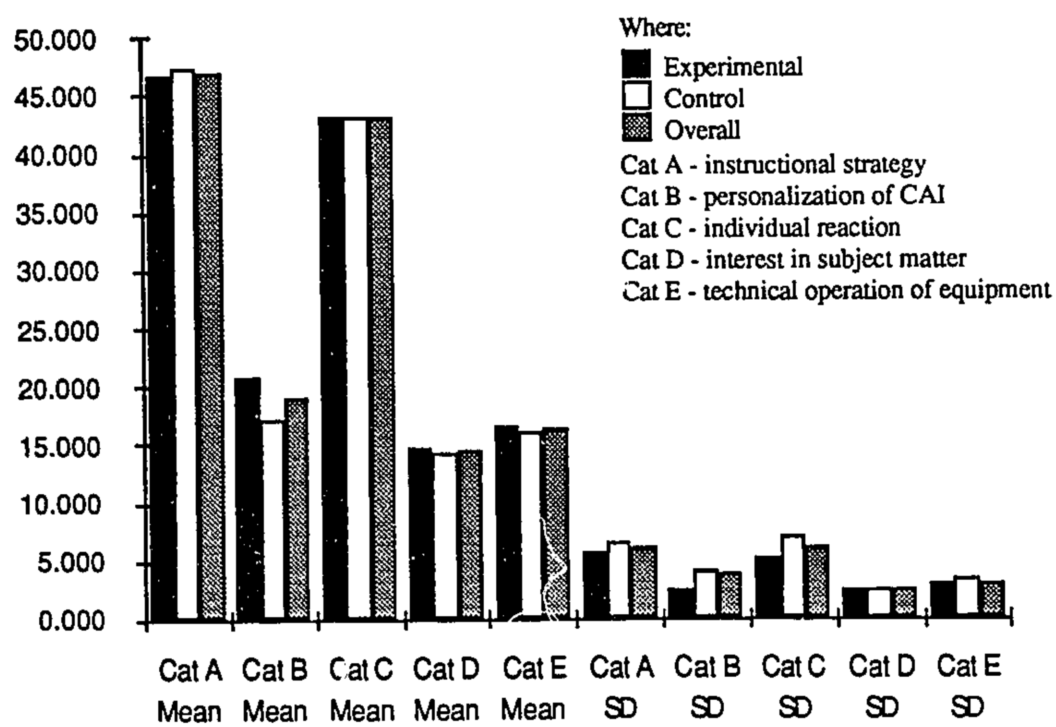
The Second Sub-problem

Data

To determine student attitude toward CBI in music, a post-treatment attitudinal measurement was taken using a Likert-type survey. The category results are raw scores in five categories, each set corresponding to one individual from either the experimental or control group. Category A deals with instructional strategy scored out of seventy. Category B deals with the personalization of CBI scored out of thirty. Category C deals with individual reaction scored out of sixty five. Category D deals with interest in the subject matter scored out of twenty. Category E deals with the technical operation of the equipment scored out of twenty-five. The total is the sum of all categories and represents an overall positive attitude toward CBI in aural skills scored out of two-hundred-ten. Table 6 and figure 5 summarize the data for the second sub-problem.

Figure 5.

Positive attitudes toward CBI in aural skills



Analysis

Reliability.

Coefficient alpha for the forty-two item attitude survey was 0.92. In addition, Cronbach's alpha, which accounts for relative weights between the five sub-categories, was 0.81. Table 3, above, shows the reliability coefficients for each of the sub-categories as well; in each case alpha is higher than the accepted minimum value of 0.65 when working with a group of scores (Frisbie, 1988). These figures indicate high internal consistency and reliability in the survey.

Main Effect.

The data indicated a small difference in opinion toward CBI in category B; a very small difference in categories A, D and E; and category C showed no difference. An ANOVA model was used to determine if any of these observed effects were significant. In order to implement the ANOVA, the raw scores were first translated into z-scores (see Table 7).

Table 7.

Standardized scores of positive attitudes toward CBI in aural skills

z-scores:	n	Cat A	Cat B	Cat C	Cat D	Cat E	Mean
Experimental	22	-.06	.50	.00	.09	.06	.12
Control	24	.06	-.46	-.00	-.08	-.05	-.11
Mean	46	.00	.00	.00	.00	.00	.00

where: Cat A-instructional strategy, Cat B-personalization of CAI, Cat C-individual reaction, Cat D-interest in subject matter, Cat E-technical operation of equipment

The data conversion to z-scores results in a non-legitimate main effect within group (the mean in each category is zero). For the purposes of this study, the within group effect was not important, however, the between group effect was important. The analysis revealed no difference between the experimental group and the control group ($p > .05$).

Interaction.

The analysis showed a significant interactive effect: $F(4,176) = 4.83$, $p < .05$.

Contrast.

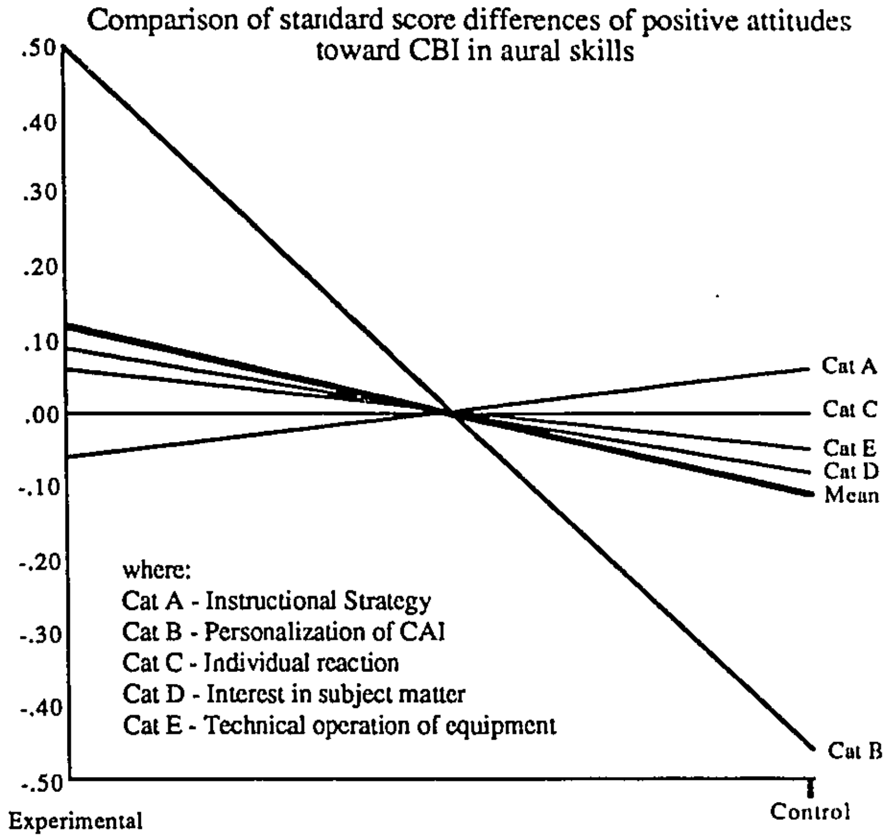
An analysis of contrasts was performed (Scheffé) in order to attempt to identify the source of the interaction. The analysis showed no significant contrasts between any of the categories ($p > .05$).

Conclusion.

The between group effect in the second sub-problem was negligible, indicating no overall difference between the experimental group and the control group (see the mean slope in figure 6). A significant interaction was noted; however, given that the subsequent contrasts revealed no differences within individual groups, the interaction was considered marginal. The z-scores for categories A, C, D and E all approached zero, however the z-scores for category B were anomalous. Even though the contrasts showed no difference, the anomalous scores in category B warrant discussion (see figure 6).

The z-scores in category B represent the participant's reaction to the personalization of the instructional material. It is interesting to note that the group using the interactive audio responded more positively toward the personalization of the program than did the group using non-interactive audio. This may indicate that interactivity results in a perceived increase in user-friendliness or personalization in CBI. This speculation is based only the anomalous slope of category B, it should be noted that statistically this score falls within the probability limits of non-significance.

Figure 6.



Chapter Summary

The two sub-problems were handled independently using statistical analysis to derive greater meaning from the raw data. The analysis was done using a probability level of .05 to determine significance. Based on test results which were reliable, the data for the first sub-problem showed significant effects, indicating that CBI with interactive audio resulted in better skill development at identifying harmonic voicing than did CBI with non-interactive audio. Based on test results which had high reliability, the data for the second sub-problem showed no significant effects, indicating that no differences regarding attitude toward CBI in aural skills were present between the two groups.

Summary, Conclusions and Recommendations

Summary

Comparing the effects of interactive audio in CBI versus non-interactive audio in CBI on the skills and attitudes of a music student in identifying harmonic voicing was divided into two sub-problems for the purposes of this study. The first sub-problem was to compare music students' skill in identifying harmonic voicing using interactive versus non-interactive audio. The second sub-problem was to compare music students' attitudes toward CBI using interactive versus non-interactive audio.

A two group pretest-posttest experiment was conducted in which forty-six participants volunteered to work with a computer program developed for this study; the experimental group used interactive audio and the control group used non-interactive audio; and, both groups completed an attitude measure. The test scores showed acceptable to high reliability. Analysis of the data revealed that the experimental group showed greater skill development than the control group in identifying harmonic voicing. Analysis of the attitudinal measurement revealed no difference between the groups.

Conclusions

The results of this study are limited to CBI in identification of harmonic voicing in aural skills and may only be generalized to similar populations of music and music education students in Canada. The attitude of the experimental group did not differ significantly from the attitude of the control group; however, all participants volunteered for the study without coercion and the sample, therefore, may have had a predisposed positive opinion about computers in music education. This could have been a factor in their decision to volunteer, and also a factor which may have affected the attitude survey - possibly resulting in a general positive attitude towards CBI in aural skills. Confidence in any generalizations regarding attitude in this study is limited.

With regard to achievement, the skill development in the experimental group was greater than that of the control group: this supports the use of CBI with interactivity in aural skills. Confidence in the measurement of achievement is supported knowing that the sample was homogenous with regard to attitude towards CBI in aural skills: discrepant attitudes between the groups can be ruled out as a possible source for differing achievement between the groups. The measurement results show acceptable to high reliability coefficients. Frisbie (1988) indicated that low reliability should be expected from groups which are homogeneous and also from groups which are not highly motivated to do their best on the tests. These two factors allow even greater confidence when considering the reliability coefficients for these measures.

Some conditions in the study may help to explain why no significant differences were found between the attitudes of the experimental and control groups. With the exception of interactive control of harmonic voices (the basis for the study), the CBI modules were identical. The participants were involved in a style of aural skills training which was relatively new and unused in regular aural skills classes and as a result the overall novelty of this instruction may have overshadowed any attitudinal differences attributable to the interactivity and may have provoked positive attitudes in all users. Previous studies indicate that students show more positive attitudes toward CBI in aural skills than toward traditional classroom aural skills training. It is likely that when both groups used CBI in aural skills, the differences in interactivity while effecting achievement may not have effected attitude.

Each participant was active in the study for approximately one hour, in which time, the pretest, treatment, posttest and attitude modules were completed. Participants may have required a longer exposure to CBI in order to offer accurate statements of attitude.

Similarly, several factors warrant discussion which may help to explain other reasons for the differences found in achievement. One hour may not have allowed enough time to accurately measure learning in a subject area which the participants have spent years studying. Claims regarding effectiveness of interactivity may require longer exposure to treatment in order to be valid. Although this study accurately shows differences in achievement between groups using interactive versus non-interactive audio, greater validity may be gained by applying the treatment over periods of time which are proportional to the time students spend learning aural skills in regular classes at university. Pretest contamination may have been a factor which resulted in increased scores on the posttest. The analysis showed no overall difference between the groups but did show a difference within the groups, possibly attributable to exposure to the pretest, however, because the participants were randomly assigned to either the control group or the experimental group and both groups took the same pretest, it is assumed that any pretest contamination would be equal for both groups, leaving any differences attributable to the treatment differences between the groups. The results of the contrast analysis support this by attributing the differences to the treatment, specifically to the interactivity built into the program used by the experimental group.

These results support the findings by Woodrulff and Heeler (1990) which indicate that interactive audio results in higher achievement by music appreciation students; and, also support Ashley's conclusions (1989) that interactive audio is effective in increasing the listening skills of music students. Support for CBI in aural skills and continued research in the area is consistent with many other studies (Arenson, 1982; Bailey, 1989; Canelos, Murphy, Blombach & Heck, 1980; Dalby, 1989; Greenfield & Codding, 1985; Hofstetter, 1978, 1979, 1980, 1981). Technology is advancing at an ever-increasing rate and the tools which become available to the aural skills student may advance to the point where comparisons with older technology are no longer valid: this only strengthens the need for ongoing research in the area.

Recommendations

Two limiting factors in this study could be eliminated in future studies. The sample size of forty-six participants is small: results using larger samples might be generalized to larger, more diverse populations. Also, the treatment time in this study was short: each student spent approximately one hour at the computer. The close proximity in time between the pretest and the posttest may have affected the test results. A study which is structured over a longer period (such as a semester) would likely allow greater confidence in the results.

This study used synthesized sounds from tone generators within the Macintosh computer. These sounds are accurate with regard to pitch and also include specific overtones which create a sound more similar to a natural sound than a sine wave; however, truly natural sounds can only be achieved through sampling technology, or very sophisticated synthesis. A study using CBI in aural skills could be designed to determine the effect of natural (sampled) sounds versus synthesized sounds on student achievement and attitude. A similar study could determine if music students respond better in aural skills to the natural sound of their major instrument than to other instruments. For example, can a trumpet major identify intervals played on a trumpet better than intervals played on a piano?

CBI has great potential for accommodating further research in aural skills with new advancements in hardware, software, MIDI and sampling technologies.

References

Arenson, M.A. & Hofstetter, F.T. (1983). High-tech models for music learning: The GUIDO system and the PLATO project. Music Educators Journal, 69(5), 46-51.

Arenson, M.A. (1982). The effect of a competency-based computer program on the learning of fundamental skills in a music theory course for non-music majors. Journal of Computer-Based Instruction, 9(2), 55-88.

Ars Nova, (1992). Practicum Musica [Computer program]. Kirkland, WA: Ars Nova.

Ashley, R.D. (1989). Redesigning the content and sequence of instruction in music theory: final report to fund for the improvement of post secondary education. Evanston, Illinois: Northwestern University. (ERIC Document Reproduction Service No. ED 340 630)

Bailey, D.L. (1989). The effects of computer-based instruction on achievement of four, five and six-year-old children in the Yamaha Music Education System Primary One Course. Dissertation Abstracts International, 51(3), 777A.

Blombach, A. K. (1989). Tools for macintosh music courseware development: Hewlett's representation system and structured programming. Journal of Computer Based Instruction, 16(2), 50-58.

Bloom, B.S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. Educational Researcher, 13(4), 4-16.

Canelos, J.J., Murphy, B.A., Blombach, A.K., & Heck, W.C. (1980). Evaluation of three types of instructional strategy for learner acquisition of intervals. Journal of Research in Music Education, 28, 243-249.

Clarkson, A.E. & Pegley, K. (1991). An assessment of a technology in music programme. (Technical report 91-2, revised edition.) Centre for the Study of Computers in Education, York University. (ERIC Document Reproduction Service No. ED 341 364)

Dalby, B.F. (1989). A computer-based training program for the development of harmonic intonation discrimination skill. Dissertation Abstracts International, 50(7), 241A.

Fons, J., & Zhang, J. (1991). Interactive audio for computer assisted learning. Journal of Educational Technology Systems, 19(1), 59-74.

Frisbie, D.A. (1988). Reliability of scores from teacher-made tests. Educational Measurement, 7(1), 25-32.

Gillespie, F., & Placek, R. W. (1991). Technology for teaching. Music Educators Journal, 77(5), 53-54.

Greenfield, D.G. & Codding, P.A. (1985). Competency-based vs. linear computer instruction of music fundamentals. Journal of Computer-Based Instruction, 12(4), 108-110.

Gross, D. & Griffin, W. (1982). Implementation and evaluation of a computer-assisted course in musical aural skills. AEDS Journal, 15(3), 143-150.

Hoffmann, J.A. (1991). Computer-aided collaborative music instruction. Harvard Educational Review, 61(3), 270-278.

Hofstetter, F.T. (1975). GUIDO: An interactive computer-based system for improvement of instruction and research in ear training. Journal of Computer-Based Instruction, 1, 100-106.

Hofstetter, F.T. (1978). Computer-based recognition of perceptual patterns in harmonic dictation exercises. Journal of Research in Music Education, 26, 111-119.

Hofstetter, F.T. (1979). Evaluation of a competency-based approach to teaching aural interval identification. Journal of Research in Music Education, 27, 201-213.

Hofstetter, F.T. (1980). Computer-based recognition of perceptual patterns in chord quality dictation exercises. Journal of Research in Music Education, 28, 83-91.

Hofstetter, F.T. (1981). Computer-based aural training: The GUIDO system. Journal of Computer-Based Instruction, 7(3), 84-92.

Hofstetter, F.T. (1981). Computer-based recognition of perceptual patterns and learning styles in rhythmic dictation exercises. Journal of Research in Music Education, 29(4), 265-277.

Humphreys, J.T. (1986). Measurement, prediction, and training of harmonic audiation and performance skills. Journal of Research in Music Education, 34(3), 192-199.

Humphries, J.A. (1980). The effects of computer-assisted aural drill time on achievement in musical interval identification. Journal of Computer-Based Instruction, 6(3), 91-98.

Kirk, R.E. (1968). Fundamental assumptions in analysis of variance. Experimental design: Procedures for the behavioral sciences. (pp. 60-63). Belmont, California: Brooks/Cole.

Kulik J.A., Kulik, C.C., & Cohen, P.A. (1980). Effectiveness of computer-based college teaching: A meta-analysis of findings. Review of Educational Research, 50(4), 525-544.

Kuzmich, J., Jr. (1989). New styles, new technologies, new possibilities in jazz. Music Educators Journal, 76(3), 41-46.

Madsen, C.K. & Geringer, J.M. (1990). Differential patterns of music listening: Focus of attention of musicians versus non musicians. Bulletin of the Council for Research in Music Education, 105, 45-57.

MiBac Music Software, (1992). Music Lessons v 1.0.1 [Computer program]. Northfield, MN: MiBac Music Software.

Newcomb, S.R. (1988). Computer-based arts instruction: How are we doing? Design for Arts in Education, 89(5), 46-49.

Newcomb, S.R., Weage, B.K., & Spencer, P. (1981). MEDICI: Tutorial in melodic dictation. Journal of Computer-Based Instruction, 7(3), 63-69.

Pembrook, R.G. (1986). Interference of the transcription process and other selected variables on perception and memory during melodic dictation. Journal of Research in Music Education, 34(4), 238-261.

Pembrook, R.G. (1986). Some implications of students' attitudes toward a computer-based melodic dictation program. Journal of Research in Music Education, 34(2), 121-133.

Pogonowski, L. (1989). Critical thinking and music listening. Music Educators Journal, 76(1), 35-38.

Sink, P.E. (1983). Effects of rhythmic and melodic alterations on rhythmic perception. Journal of Research in Music Education, 31(2), 101-113.

Taylor, J.A. (1982). The MEDICI melodic dictation computer program: Its design, management, and effectiveness as compared to classroom melodic dictation. Journal of Computer-Based Instruction, 9(2), 64-73.

Taylor, J.A. (1988). Computers in music and music instruction: The joys of hardware and the woes of software. Design for Arts in Education, 89(5), 50-55.

Upitis, R. (1982). A computer-assisted instruction approach to music for junior-age children: Using ALF for teaching music. (Paper presented at the International Computer Music Conference, Venice, Italy, September 1982). Queen's University, Kingston, Ontario. (ERIC Document Reproduction Service No. ED 225 650)

Weintraub, D. (1991). Improving retention in music fundamentals through the use of computer based instruction. (Ed D Practicum). Nova University. (ERIC Document Reproduction Service No. ED 336 072)

Winer, B.J. (1971). Statisical principles in experimental design (2nd ed.). New York: McGraw Hill.

Woodrulff, E., & Heeler, P. (1990). A study of the use of intractive videodisc technology to present aural tests to college music appreciation students. (National Educational Computing Conference Proceedings). Nashville, TN. (ERIC Document Reproduction Service No. ED 329 232)

Woodrulff, E., & Heeler, P. (1991). A computer-based tutorial system to develop listening skills using CD-ROM. (Paper presented at the Joint conference of the Educational Computing Organization of Ontario and the International Conference on Technology and Education). Toronto, Ontario. (ERIC Document Reproduction Service No. ED 346 840)

Appendix A

A copy of the user instructions for access to the computer program is enclosed.

Appendix A - Pages 41 & 42 Have been

Removed due to poor print quality

Appendix B

Hard copies of the items on the pretest, posttest and opinion measure are enclosed.

Pretest and Posttest Questions

The pretest and posttest are visually identical however the audible samples are different. Twenty items are on each test: in each item the computer plays a triad and the user is prompted to identify the triad. Each item is in multiple choice format with four choices as follows:

a. Major b. Minor c. Diminished d. I don't know.

1 Identify the chord quality of this triad. Would you call it major, minor, or diminished?

2 Identify this chord as major, minor, or diminished.

3 Again, identify the quality of this chord. Is it major, minor, or diminished?

4 Again, identify the quality of this chord. Is it major, minor, or diminished?

5 Although this chord is built on a different note, it can be identified as either major, minor, or diminished. Which one?

6 Is this chord major, minor, or diminished?

7 Is this chord major, minor, or diminished?

8 Is this chord major, minor, or diminished?

9 Is this chord major, minor, or diminished?

10 Is this chord major, minor, or diminished?

11 Is this chord major, minor, or diminished?

12 Is this chord major, minor, or diminished?

13 Is this chord major, minor, or diminished?

14 Is this chord major, minor, or diminished?

15 Is this chord major, minor, or diminished?

16 Is this chord major, minor, or diminished?

17 Is this chord major, minor, or diminished?

18 Is this chord major, minor, or diminished?

19 Is this chord major, minor, or diminished?

20 Is this chord major, minor, or diminished?

An instrument to measure opinion toward CBI

The instrument has 42 items, each of which is answerable in a five scale Likert-type format. Each item is labelled with a (+) or (-) to indicate whether it is positively or negatively worded; in addition, each item is classified into one of five categories (A-E).

The scores calculated include the individual's TOTAL score and SUBSCORE on each of the 5 subscales of the instrument. The numerical weights assigned to the individual responses are listed below:

Response Type	Positive	Negative
Strongly agree / All the time	5	1
Agree / Most of the time	4	2
Uncertain / Some of the time	3	3
Disagree / Very seldom	2	4
Strongly disagree / Never	1	5

The five SUBSCORES are designed to measure the student's opinion toward:

A. the instructional strategy;
B. the personalization of CBI;
C. individual reaction;
D. interest in the subject matter; and,
E. technical operation of the equipment.

1 A- The method by which I was told whether I had given a right answer became monotonous.
Strongly disagree   Disagree   Uncertain   Agree   Strongly agree

2 B- Nobody really cared whether I learned the material or not.
Strongly disagree   Disagree   Uncertain   Agree   Strongly agree

3 C+ I felt challenged to do my best work.
Strongly disagree   Disagree   Uncertain   Agree   Strongly agree

4 C- I felt isolated and alone.
All the time   Most of the time   Some of the time   Very seldom   Never

5 B+ I felt as if someone were engaged in conversation with me.
All the time   Most of the time   Some of the time   Very seldom   Never

6 B+ As a result of having studied by this method, I am interested in practicing more aural skills.
Strongly disagree   Disagree   Uncertain   Agree   Strongly agree

7 E- I was more involved in operating the terminal than in understanding the material.
All the time   Most of the time   Some of the time   Very seldom   Never

8 E- The learning was too mechanical.
Strongly disagree   Disagree   Uncertain   Agree   Strongly agree

9 B+ I felt as if I had a private tutor.
Strongly disagree   Disagree   Uncertain   Agree   Strongly agree

10 B- The computer made it difficult to concentrate on the material.

All the time Most of the time Some of the time Very seldom Never

11 C- The situation of learning by computer made me quite tense.
Strongly disagree Disagree Uncertain Agree Strongly agree

12 A- Computer-assisted instruction, as used in this program, is an inefficient use of the student's time.
Strongly disagree Disagree Uncertain Agree Strongly agree

13 D+ My feeling toward aural skills at this time is favorable.
Strongly disagree Disagree Uncertain Agree Strongly agree

14 C- I felt frustrated by the situation.
Strongly disagree Disagree Uncertain Agree Strongly agree

15 A- I found the computer-assisted instruction approach in this program to be inflexible.
Strongly disagree Disagree Uncertain Agree Strongly agree

16 D- Material which is otherwise interesting can be boring when presented by CAI.
Strongly disagree Disagree Uncertain Agree Strongly agree

17 C+ I was satisfied with what I learned during the program.
Strongly disagree Disagree Uncertain Agree Strongly agree

18 C+ Given the amount I learned, this method seems better than classroom instruction for aural skills.
Strongly disagree Disagree Uncertain Agree Strongly agree

19 C+I would prefer computer-assisted instruction to traditional instruction.
Strongly disagree Disagree Uncertain Agree Strongly agree

20 B- Computer-assisted instruction is just another step toward de-personalized instruction.
Strongly disagree Disagree Uncertain Agree Strongly agree

21 D- I was concerned that I might not be understanding the material.
Strongly disagree Disagree Uncertain Agree Strongly agree

22 A+ The responses to my answers seemed appropriate.
All the time Most of the time Some of the time Very seldom Never

23 A+ I felt uncertain as to my performance during the program relative to the performance of others.
All the time Most of the time Some of the time Very seldom Never

24 C+ I was not concerned when I missed a question because nobody was watching me.
Strongly disagree Disagree Uncertain Agree Strongly agree

25 C- I found myself trying to get through the material rather than trying to learn.
All the time Most of the time Some of the time Very seldom Never

26 A- I knew whether my answer was right or wrong before I was told.
All the time Most of the time Some of the time Very seldom Never

27 C- When I am trying to learn things, it is important to me to know where I stand relative to others.
Strongly disagree Disagree Uncertain Agree Strongly agree

28 C- I guessed at the answers to some questions.
All the time Most of the time Some of the time Very seldom Never

29 A+ I was aware of efforts to suit the material specifically to me.
All the time Most of the time Some of the time Very seldom Never

30 A+ I was encouraged by the responses given to my answers to questions.
Strongly disagree Disagree Uncertain Agree Strongly agree

31 A- In view of the time allowed for learning, I felt too much material was presented.
Strongly disagree Disagree Uncertain Agree Strongly agree

32 E- I entered wrong aswers in order to get more information from the computer.
All the time Most of the time Some of the time Very seldom Never

33 A+ I felt I could work at my own pace.
Strongly disagree Disagree Uncertain Agree Strongly agree

34 A- Questions were asked which I felt were not related to the materials presented.
All the time Most of the time Some of the time Very seldom Never

35 E- I was aware of the slow speed of the computer while I was taking the course.
All the time Most of the time Some of the time Very seldom Never

36 D+ Material which is otherwise boring can be interesting when presented by CAI.
Strongly disagree Disagree Uncertain Agree Strongly agree

37 C- I could have learned more if I hadn't felt pushed.
Strongly disagree Disagree Uncertain Agree Strongly agree

38 A- I was given answers but still did not understand the questions.
All the time Most of the time Some of the time Very seldom Never

39 A- The course material was presented too slowly.
All the time Most of the time Some of the time Very seldom Never

40 A+ The response to my answers seemed to take into account the difficulty of the questions.
Strongly disagree Disagree Uncertain Agree Strongly agree

41 E- While on computer-assisted instruction, I encountered mechanical malfunctions.
All the time Most of the time Some of the time Very seldom Never

42 C- Computer-assisted instruction did not make it possible for me to learn quickly.
Strongly disagree Disagree Uncertain Agree Strongly agree

43 What did you like BEST about Aural Skills in CBI? Type your answer below and press Return when finished.

44 What did you like LEAST about Aural Skills in CBI? Type your answer below and press Return when finished.

Appendix C

The data file which is created by the Authorware modules is called "MassData" and is created in the same location as the RunAPM file used to run the modules. The record layout of the file is as follows:

Column 1	-group ID(1 or 2),
Column 2-21	-pretest answers (1, 2, 3, or 4),
Column 22-41	-posttest answers (1, 2, 3, or 4),
Column 42-83	-attitude responses (1, 2, 3, 4, or 5).

Following column 83 is a TAB-delimited series of numbers:

Pretest total	-out of 20,
Listen again	-number of times the user asked to re-hear a music sample,
Volume control	-number of times the user adjusted the volumes of voices,
Posttest total	-out of 20,
Attitude category A	-total out of 70,
Attitude category B	-total out of 30,
Attitude category C	-total out of 65,
Attitude category D	-total out of 20,
Attitude category E	-total out of 25,
Attitude total	-total out of 210.

A file listing of the raw data totals gathered in this study is enclosed.

Where:

column A -	group ID (1=experimental, 2=control)
column B -	pretest scores
column C -	posttest scores
column D -	attitude category A
column E -	attitude category B
column F -	attitude category C
column G -	attitude category D
column H -	attitude category E
column I -	attitude total of all categories.

Raw data totals.

A	B	C	D	E	F	G	H	I
2	08	12	49	18	45	15	18	145
2	13	14	55	19	51	15	18	158
2	12	11	47	11	42	12	15	127
2	10	16	44	13	30	10	14	111
1	09	11	41	20	44	13	13	131
1	13	16	47	21	46	14	18	146
1	17	19	50	22	42	14	13	141
2	17	20	57	24	45	14	20	160
1	17	17	53	19	47	16	19	154
1	18	19	47	20	41	13	17	138
2	15	16	41	14	48	15	16	134
2	17	15	38	12	34	12	09	105
1	10	11	44	18	32	09	12	115
2	11	11	45	20	47	15	20	147
2	16	17	41	15	48	18	18	140
2	17	17	40	15	38	14	11	118
1	06	08	35	15	27	11	12	100
1	09	09	45	22	45	16	14	142
1	09	11	47	20	40	17	21	145
1	16	17	55	26	46	12	15	154
2	18	20	60	22	46	18	17	163
1	16	16	49	20	45	19	17	150
1	17	20	42	23	49	15	16	145
2	13	13	38	15	37	10	11	111
2	17	14	50	17	54	16	21	158
2	14	12	51	14	46	13	17	141
2	06	08	46	15	43	16	13	133
2	14	15	48	22	48	17	17	152
2	15	15	41	16	36	16	14	123
2	09	15	40	15	28	11	14	108
1	10	13	46	21	48	17	21	153
1	13	17	47	23	46	15	18	149
1	18	17	52	24	47	18	19	160
2	18	17	56	23	44	14	18	155
1	15	17	55	22	48	16	18	159
1	20	20	45	22	43	12	16	138
2	08	11	49	19	48	12	16	144
2	14	16	49	16	47	16	17	145
2	10	08	54	16	51	16	18	155
1	08	08	44	21	46	14	13	138
1	14	14	51	19	44	17	20	151
1	15	16	53	21	41	14	14	143
2	19	20	55	26	45	16	21	163
1	16	15	34	16	39	13	16	118
1	14	17	44	21	41	16	18	140
2	12	16	42	13	32	09	12	108

Appendix D

User documentation for SndCmd XFCN is enclosed. SndCmd is included in the Authorware Modules found in the thesis pocket.

User Documentation for SndCmd XFCN

SndCmd allows you to create and play tones using the internal tone generators in the macintosh. Four voices can be used and SndCmd provides facilities to set the notes for all four voices, control the volume of all four voices, set the waveform of all four voices and set global tempo control.

Initializing SndCmd

An initialization must be done before SndCmd can be operated:

SndCmd ("Init")

Closing SndCmd

SndCmd must be closed prior to exiting from the application which called it:

SndCmd ("Close")

Control Variables

SndCmd uses the following global variables:

baseRate - integer with a range of 1 - 32,767. This variable determines how long the duration of notes will be. BaseRate is measured in 1/2 milliseconds (a baseRate of 2000 would result in a basic duration of notes of one second). An integer within the acceptable range must be stored in the variable called baseRate in order for SndCmd to recognize the tempo control.

Volume1, Volume2, Volume3, and Volume4 - integer with a range of 0 - 255. These variables control the volume of each of the four voices independently. An integer within the acceptable range must be placed into each of the four volume variables (Volume1, Volume2, Voume3 and Volume4) in order to set the volume level of the voices.

Setting the Waveform

SndCmd can assign one of sixteen waveforms to each individual voice. The command to set the wave is:

SndCmd ("SetWave", X_1, Y_1, X_2, Y_2, X_3, Y_3, X_4, Y_4) where $X_{1\text{-}4}$ is the voicenumber integer range 1-4 and $Y_{1\text{-}4}$ is the waveform integer range 1-16.

Creating Note Sequences

Each of the four voices can play a sequence of notes, however each sequence must be placed into a variable for SndCmd to access. You may use any name for the variables (avoid reserved names in the software you are using and avoid other variable names associated with SndCmd). A sequence of notes contains note names and note durations, each pair separated by a comma:

name/duration,name/duration,name/duration. For example, you could store the notes c, d, e, f, and g into a variable called voice1 with each note duration twice the baseRate (see Control Variables):

voice1:= "c3/2,d3/2,e3/2,f3/2,g3/2"

The note range is from C0 to G8 (MIDI notes 24 to 127) where C3 is middle C (MIDI note 60). Sharps and flats are specified after the note name and before the note number with a "#" and a lower case letter B: "b". A rest is specified in place of a note with a "0", "x" or "X". The note is followed by a forward slash. The note duration specifies the time in number of baseRate units the note will be played for. For example, you could store an A major scale starting on the A below middle C with rests between each note and the duration of each rest one half that of each note:

melody1:="a2/4,x/2,b2/4,X/2,c#3/4,0/2,d3/4,x/2,e3/4,x/2,f#3/4,x2,g#3/4,x2/a3/4"

Playing Note Sequences

Two commands allow you to start and stop play using SndCmd:
To start playing note sequences you have previously stored in variables:

SndCmd ("PlayCadence", var1,var2,var3,var4)
where var1-4 are the variables you set with note sequences.

To stop playing note sequences:

SndCmd ("StopPlay")

To ensure that the sound system of the macintosh repsonds to all the commands of SndCmd, it is necessary to place a "loop" command preceeding each PlayCadence or StopPlay command:

SndCmd ("Loop")

Building Waveforms

You can specify the amplitudes of the first 32 harmonics of any of the 16 waveforms. The amplitudes are integers ranging from 0 - 32000 and are stored in global variables called Harm01, Harm02, Harm03, ... Harm32. The amplitudes are actually relative values therefore the following two examples of amplitude values would result in exactly the same wave:
(1000,500,250,500,0,0,0...0) and (100,50,25,50,0,0,0...0).
The command "MakeWave" will use the values in the 32 Harm variables to create a wave and store it in one of the 16 possible waveforms:

SndCmd ("MakeWave", *wavenumber*)
where wave number is an integer within the range 1-16.

Sample Authorware Calculation

The following calculation in Authorware sets the 32 Harm variables to form a sine wave, it sets the baseRate and volume variables and sets four sequences of notes. It initializes SndCmd then makes a sine wave pattern in waveform number 1 . The note sequences are played simultaneously and then SndCmd in closed.

```
Harm01:=100          ;set the first harmonic to 100
Harm02:=0            ;set the remaining harmonics to zero
Harm03:=0            ;
Harm04:=0            ;
Harm05:=0            ;
Harm06:=0            ;
Harm07:=0            ;
Harm08:=0            ;
Harm09:=0            ;
Harm10:=0            ;
Harm11:=0            ;
Harm12:=0            ;
Harm13:=0            ;
Harm14:=0            ;
Harm15:=0            ;
Harm16:=0            ;
Harm17:=0            ;
Harm18:=0            ;
Harm19:=0            ;
Harm20:=0            ;
Harm21:=0            ;
Harm22:=0            ;
```

```
Harm23:=0                               ;
Harm24:=0                               ;
Harm25:=0                               ;
Harm26:=0                               ;
Harm27:=0                               ;
Harm28:=0                               ;
Harm29:=0                               ;
Harm30:=0                               ;
Harm31:=0                               ;
Harm32:=0                               ;
Voice1:="G2/4,0/2,C2/4"                 ;set a note sequence in voice1
Voice2:="B2/4,0/2,C3/4"                 ;set a note sequence in voice2
Voice3:="D3/4,0/2,E3/4"                 ;set a note sequence in voice3
Voice4:="G3/4,0/2,G3/4"                 ;set a note sequence in voice4
Volume1:=250                            ;set volume for first voice
Volume2:=240                            ;set volume for second voice
Volume3:=230                            ;set volume for third voice
Volume4:=220                            ;set volume for fourth voice
baseRate:=1000                          ;set baseRate to 500 milliseconds (units are
0.5ms)
SndCmd ("Init")                         ;initialize SndCmd
SndCmd ("MakeWave",1)                   ;use Harm variables to make wave number 1
SndCmd ("SetWave",1,1,2,1,3,1,4,1)      ;set all four voices to the first wave number
SndCmd ("Loop")                         ;loop command
SndCmd ("PlayCadence", voice1, voice2, voice3, voice4);  play note sequences
SndCmd ("Close")                        ;close down SndCmd
```