DOCUMENT RESUME

ED 380 121 IR 055 424

AUTHOR Worthington, Trent G.; Szabo, Michael
TITLE Interactivity in Computer-Based Aural Skills Instruction: A Research Study.
PUB DATE Feb 95
NOTE 17p.; Paper p_esented at the Annual Meeting of the Association for Educational Communication and Technology (Anaheim, CA, February 1995).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Audiolingual Skills; Auditory Training; *College Students; Comparative Analysis; *Computer Assisted Instruction; Higher Education; Identification; *Interaction; *Music; Pretests Posttests; Skill Development; *Student Attitudes; Tables (Data)
IDENTIFIERS *Harmonics

ABSTRACT

Comparing the effects of interactive audio in computer-based instruction (CBI) versus noninteractive audio in CBI on the skills and attitudes of music students in identifying harmonic voicing was divided into two subproblems for this study. The first was to compare students' skill in identifying harmonic voicing using interactive versus noninteractive audio. The second was to compare music students' attitudes toward CBI using interactive versus noninteractive audio. A two-group pretest-posttest experiment was conducted in which 46 participants volunteered to work with a computer program developed for this study. The experimental group used interactive audio and the control group used noninteractive audio. Both groups completed an attitude measure. The test scores showed acceptable to high reliability. Analysis of the data reveal that the experimental group showed greater skill development than the control group in identifying harmonic voicing. Analysis of the attitude measure reveals no difference between the groups. Four tables and four figures illustrate the study. An appendix describes the program and introduces some music terminology. (Contains 36 references.) (SLD)

INTERACTIVITY IN COMPUTER-BASED AURAL SKILLS INSTRUCTION: A RESEARCH STUDY

Trent G. Worthington
The King's University College
Edmonton, Alberta, Canada
and
Michael Szabo, Ph.D.
University of Alberta
Department of Educational Psychology
Division of Technology in Education
Edmonton, Alberta, Canada

INTERACTIVITY IN COMPUTER-BASED AURAL SKILLS INSTRUCTION: A RESEARCH STUDY

Trent G. Worthington
The King's University College
and
Michael Szabo, Ph.D.
University of Alberta

Comparing the effects of interactive audio in Computer-Based Instruction (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.

The subject area of study is aural skills training in music. 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. 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. Using CBI for aural training in music implies the use of audio: it is not the purpose of this study to examine the use of audio in CBI but to examine the implications of allowing user-control of specific parameters of the audio. 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. 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. Interactivity in this context refers to audible samples of three part harmonies utilizing user control of individual voice volume.

Review of Related Literature

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, harmonics, 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. 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). A series of four studies all 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. 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.

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).

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.

Summary

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. CBI in aural skills has been effective both in terms of achievement and student attitude. 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. 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)

The Current Study

Statement 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.
Two sub-problems were used:
1) to compare music students' skill development in identifying harmonic voicing using interactive audio in CBI with those using non-interactive audio in CBI; and,
2) to compare music students' attitudes toward CBI in aural skills and interactive audio with those toward CBI in aural skills and non-interactive audio.

Method

The participants were a volunteer sample from an accessible population of university music students studying aural skills. Approximately ninety-five students were eligible for the study and forty-six volunteered to participate. 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 one session, lasting approximately one hour, on the same equipment. The study included musical content consisting of differentiation of major, minor and diminished triads.

The experiment was structured as a pretest-posttest control group design : similar in design to Hofstetter (1979) and Woodrulff & Heeler (1990). 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.

Instrumentation

A computer program in four parts developed with Authorware Professional © version 1.7 for Macintosh was used to deliver the lesson and collect data. This platform was chosen because of the familiarity the aural skills students had with Macintosh computers from use in the aural skills course. The program was developed carefully with input from both instructional designers and content experts. Two customized features were used with Authorware

Professional: an external command (XFCN) was built to play the triads (SndCmd XFCN uses control parameters to generate wave patterns at defined frequencies using the internal tone-generators in the Macintosh. using System 7) and a modified version of the RunAPM file was used to deliver the program (the "return" icon used in Run APM version 1.7A.1 was modified to match the arrow icons used in the program).

Results for the First Sub-problem

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 1 and Figure 1.

Insert Table 1 and Figure 1 about here

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.

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 2). 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: $F(1,44) = 15.91$, $p < .05$. Analysis revealed no interactive effect between the groups: $F(1,44) = .10$, $p = .75$ (the interactive effect is shown in figure 2).

Insert Table 2 & Figure 2 about here

An apriori hypothesis tested using 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: $F(1,44) = 2.65$, $p = .11$. Winer (1962, p. 85) observed "The apriori type is always justified whether or not the overall *F* is significant".

Conclusion regarding the First Sub-problem.

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 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.

Results for the Second Sub-problem

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 3 and figure 3 summarize the data for the second sub-problem.

Insert Table 3 and Figure 3 about here

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. 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. 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 4).

Insert Table 4 and Figure 4 about here

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, ho vever, the between group effect was important. The analysis revealed no difference between the experimental group and the control group ($p>.05$). The analysis showed a significant interactive effect: $F(4,176) = 4.83$, $p < .05$.

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 regarding the Second Sub-problem.

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 3). 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 4).

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.

Summary of Results

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.

Conclusions and Recommendations

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.

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.

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.

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.

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.

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). 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.

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)

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).

Winer, B. J. (1962). Statistical principles in experimental design. NY: McGraw-Hill.

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)

Tables and Figures

Table 1.

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 1.

Test scores of identification of harmonic voicing

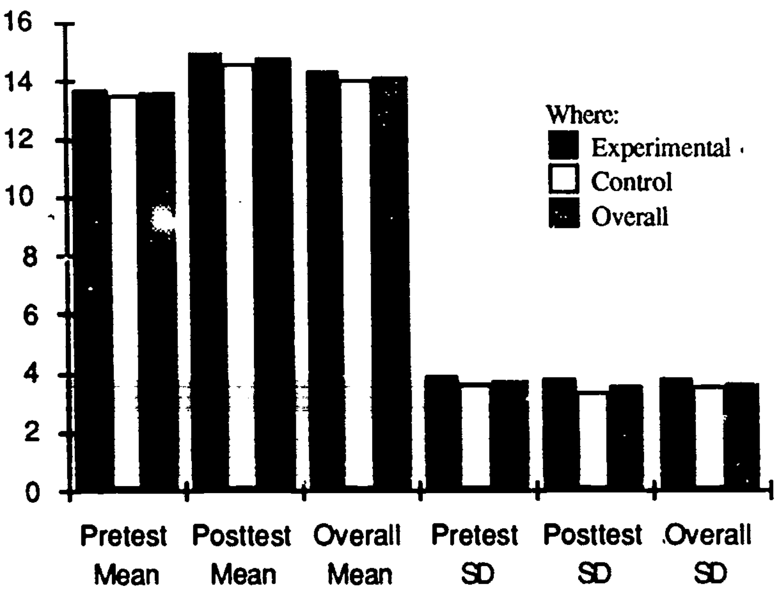


Table 2.

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	

* $p < .05$

Figure 2.

Comparison of score differences in identification of harmonic voicing

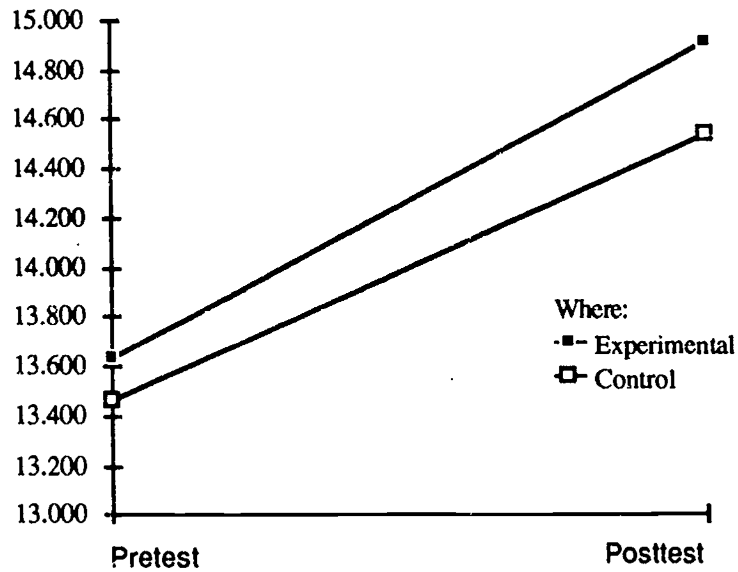


Table 3.

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

Figure 3.

Positive attitudes toward CBI in aural skills

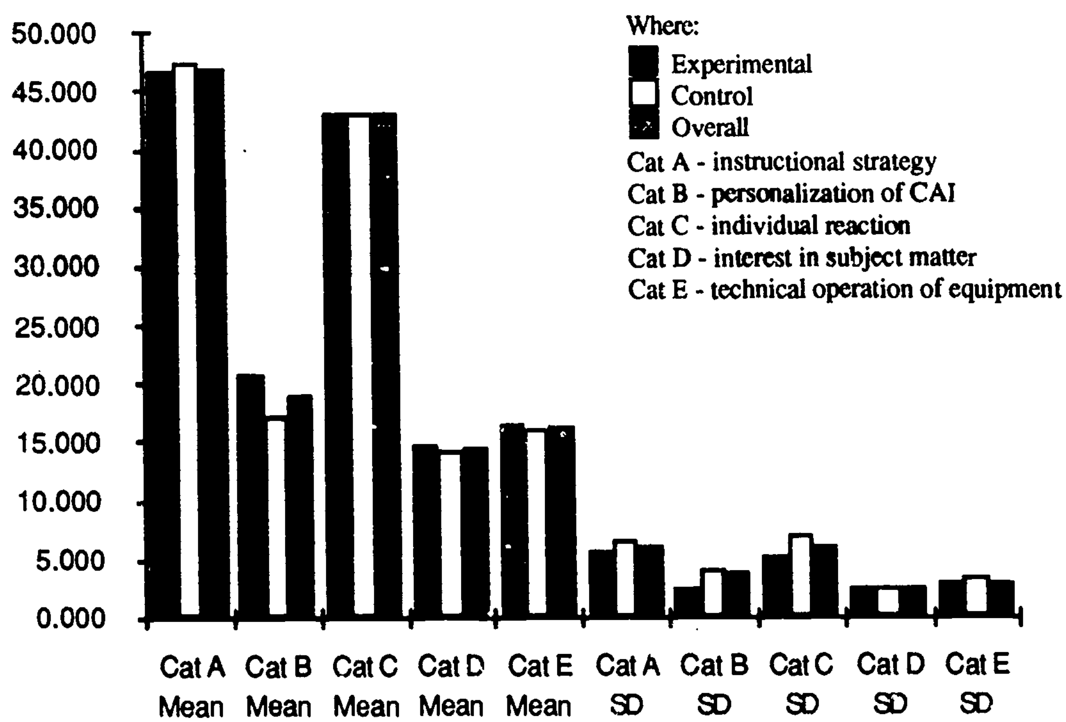


Table 4.

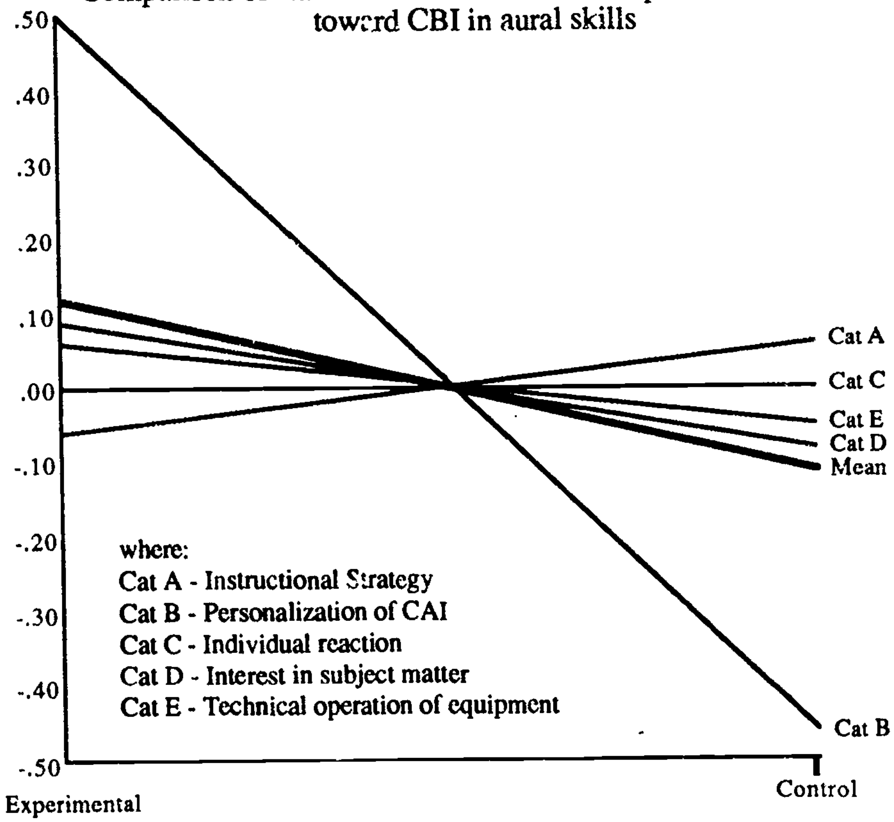
Standardized scores of positive attitudes toward CBI in aural skills

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

Figure 4.

Comparison of standard score differences of positive attitudes towεrd CBI in aural skills



Appendix

Description of the Program

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 below.

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.

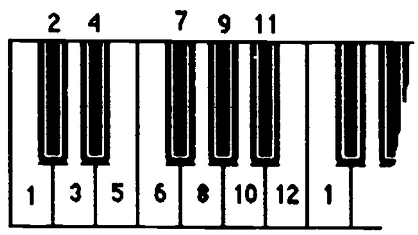
The program was validated by content experts in aural skills. The supervisor of aural skills in the music department provided content information during the construction of the program, made revisions and subsequently approved the program following completion. In addition, a music education faculty member 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.

Music 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. The figure below shows the repeating scale of semitones on the familiar piano keyboard.

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).

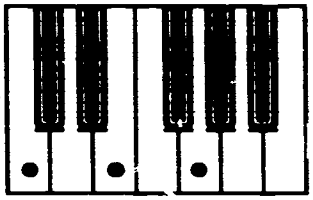
A minor triad is formed from a minor third and a major third. For example, a minor triad could be formed from note 1 and note 4 (minor third) and note 8 (a major third from note 4).

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).

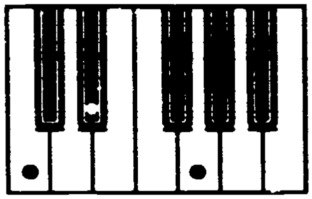
Similarly, triads can be formed from any starting note as long as the intervals remain relative. For example, a major triad could be formed starting on note 3 and would consist of note 3, note 7, and note 10. A minor triad could also be formed starting on note 3 and would consist of note 3, note 6 and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

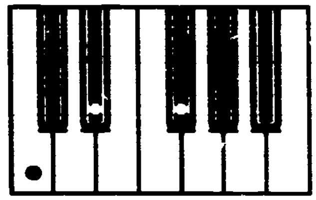
Major, minor and diminished triads on piano



Major



Minor



Diminished