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Mona Listen: A Web-Based Ear Training Module for Musical Pitch Discrimination of Melodic Intervals

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Abstract: This study investigated the effects of Web-based pitch discrimination training on college music students' achievement in melodic interval discrimination. Mona Listen, a Web-based learning module for pitch discrimination, was developed as a training and data collection tool for the study. Practice records, participants' feedback, and achievement scores of pretest, posttest and follow-up posttest served as the data for a repeated measure design study. Data analyses were conducted using *t*-test and analysis of variance. Focus-group interview provided additional data not collected with the online instrument. The findings of the study indicated that: (a) Web-based pitch discrimination training had an overall positive effect on achievement in melodic interval discrimination, and (b) the amount of time spent was not a good predictor of achievement due to other possible underlying factors.

Introduction

Pitch discrimination is important to college music students because higher-level music classes often require the students to have a firm foundation in basic listening skills. The improvement of pitch discrimination skill by way of ear training provides the means for first year college music students to learn the relationships of the musical pitches and to attain good listening skills. Conceptually, ear training enhances the pleasure of music listening and sensitizes a musician's ears for the study, comprehension, performance, and creation of music. Operatively, ear training enables a musician to identify intervals, chord qualities, rhythmic patterns, and to audiate harmonic and melodic phrases necessary for creating and performing music.

Music students unable to comprehend what they heard will often have problem reproducing or distinguishing the differences in pitches. One integral part of music education and training for college music student is, therefore, to learn to hear (Kraft, 1967). Burns and Ward (1982), as well as Killiam, Lorton, and Schubert (1975), have documented that successful musicians are usually well versed in identifying musical intervals, and are able to identify scores of intervals readily and accurately. Ear training further allows musicians to experience music more completely. Because better listeners make better musicians (Worthington & Szabo, 1995), college music students who possess better listening skills are more likely to succeed as musicians. Students who hope to improve their musical ability should therefore develop their musical pitch discrimination ability to become better listeners.

Technology-Enhanced Music Instruction

The Graded Units for Interactive Dictation Operations, or G.U.I.D.O., was the first ear-training "software" developed in the mid 1970s using the PLATO mainframe to provide programmed instruction for the recognition of intervals, melodies, chords harmonies and rhythms for college music students (F. L. Hofstetter, 1978; F. T. Hofstetter, 1975, 1985; Peters, 1992; G.D. Peters & B.L. Beiley, 1995). Reports of the positive effects on the early use of CAI for aural skills development eventually lead to the incorporation of CAI into college music theory curriculum (Davis, 2001; Eddins, 1981). Since then, CAI for ear training was regarded not only as a feasible substitute for classroom music instruction (Deihl, 1971; Killam, 1984; Kuhn & Allvin, 1967; Wittlich, 1987), but also a reasonable and effective 'tutor' (R. P. Taylor, 1980) capable of assisting students' learning within the instructional paradigm of ear training, and many subject areas (Kemmis, Atkin, & Wright, 1997). The recent educational reform to put more computers into classrooms and campuses means that the trend will persist for some time to come.

According to a nationwide study (Spangler, 1999), more than 90% of 209 music schools surveyed in the U.S. continue to make use of ear-training CAI extensively in their college music theory classes. However, obstacles such as limited copies of software, and limited number of computers for students to access the ear training software have continued to plague the music classrooms. Music instructors have expressed their concerns that the lack of access to ear training CAI could negatively impact student achievement. The instructional problem faced by educators was that music students could not effectively practice the ear-training exercises needed to improve their aural skills, which is caused by limited physical and computer-based resources, such as available laboratory time, number of computers for practice, and copies of ear training software.

Rationale

Since late 1980s, the advent of the Internet and uprising trends towards online learning has lead to new opportunities to provide ear training through online instruction. Because appropriately designed educational Websites have been shown to be motivational to students (Arnone & Small, 1999; Loh & Williams, 2002), instructors should make use of the increasingly ubiquitous Internet for music instruction. Many advantages found in earlier generations of CAI, such as individualized instruction, timely feedback, and repeatable instruction, have been retained in Web-based music instruction (WBMI), with the added advantages of self-paced instruction, on-demand delivery of online instruction via the Internet, and anytime anywhere learning. As developers creates new materials for Web-based delivery, some have focused on the improvement of existing CAI to include the Web as an additional resource, while others reckoned the Web to be a completely different delivery medium altogether. Web-developers considered the platform-independent Web to be a good medium for content delivery because the content needed to be developed only once, and was immediately usable on most computers, significantly reducing the cost of development (Lake, 2002). The gradual metamorphosis of the Internet into some kind of an operating system has been suggested as the beginning of a new wave of technology-based music instruction (Bowyer, 2000).

However, compared with the extensive pitch discrimination documentations found in psychoacoustics, music psychology and music education research, and the voluminous writings about the use of CBI in learning, the amount of research on pitch discrimination in music classroom with CBI is very limited. There were even less CBI pitch discrimination studies with college students as participants (Coffman, 2000). Compared with Web-based instructions available on the Internet, the shortage of sound, pedagogy-based WBMI have lead many music educators to criticize Web access in music classroom as “wasting time” (Spangler, 1999). The wide gap in the literature on the use and effects of innovative technology and WBMI at the college level points to a ripe opportunity for increase research and development on innovative WBMI to meet the needs of music instruction in the future. Music educators need to reconsider current classroom practice for music instruction, including ear training, in view of the affordances of current available technology.

Instructional technology is a field of study that incorporates innovative technology for the purpose of instruction and instructional development. Changes in technology has brought about many authoring tools that are suitable for non-programmer educator-developers (Khan, 1997). The development of WBMI will further prepare the way for other music courses geared towards online certification. Instructional technologists and music researchers should work in collaboration to improve future music education through technology-enhanced and Web-based music instruction. The design and development of a Web-based ear training instructional module for pitch discrimination to improve the achievement of music students in interval discrimination is, therefore, of value to both fields of music instruction and instructional technology. The availability of such WBI for music instruction also means that music students will no longer be required to congregate at a music laboratory for ‘drill-and-practice’ exercises in ear training. Because many college students now have easy access to the Internet and Web resources from campuses and dormitories, there will be more opportunity for music students to improve their ear training skill should online ear training become more readily available. These students will eventually be able to access the Web for WBMI at a time and space of their convenience and choosing, beyond the physical constraints of music classrooms and computer laboratories.

Research Questions

College music program typically mandates ear training as part of the basic music theory classes for first and second year college music students. In ear training classes, students are often required to identify music intervals played by their instructors. The musical intervals involved would normally comprised of two musical notes played either simultaneously or subsequently, being harmonic or melodic intervals, respectively; or in stacks of three or more notes, in which case they would be known as chords. Because an acoustic piano allows music instructors the liberty to produce a wide range of musical notes and styles, it has been widely accepted as the instructional tool of choice in a music classroom; henceforth, for ear training also. Other music educators advocate that instrument sounds other than piano also ought to be used to create an authentic learning environment for player of those instruments.

Because environmental and instructional factors have been shown not to play a significant role in the development of aural skills (Heritage, 1986), researchers believed there were other extraneous factors involved, that would better account for the effect of CBMI than simply computing technology. Amongst these factors, prior musical learning and instrument playing experience has been suggested to have a significant effect on a person's musical achievement (Sloboda & Davidson, 1996). Additionally, do musical factors such as play order of the melodic intervals and instrument sound used affect ear training achievement? The main research question is therefore: "What are the effect of Web-based pitch discrimination training in general, and in relation to prior musical experience?"

While current classroom practice is an end-result of what work in the classrooms over the years, advances in technology and development of new instructional tools and methods can often help to improve current practices. Pitch discrimination training can benefit from the integration of instructional design and technological advances to improve lesson delivery and classroom instruction. Despite no significant difference in test scores reported (Ozeas, 1991), students using CAI were reported to achieve the same results in a much shorter timeframe than the control group using traditional instruction. Thus, CAI for music instruction was believed to be more effective because students require less class time, and less teacher intervention (Bowman, 1984; Taylor, 1982). While some researchers asserted that there was a direct relationship between the proficiency of musical skill of musicians and the amount of time their spent on practicing the skill (Morrison, 2000; Sloboda & Davidson, 1996), other researchers could not establish any significant effect between the amount of time spent in CAI for music instruction and student post-test achievement (Fortney, 1993; Heritage, 1986; Hess, 1994). This seemed an intriguing issue and brought forth the second research question: "Does the amount of time spent on Web-based ear training affect participants' pitch discrimination achievement?"

An online ear-training module named Mona Listen has been developed for this study with the dual purpose of providing training and collecting data. The online instructional module made use of innovative technologies such as Macromedia Flash, PHP, and MySQL to enhance lesson delivery, assessment of pitch discrimination achievement, and tracking of students' progressive throughout the data collection period. Realistic piano and guitar sound in MP3 format was incorporated as sound source to provide a better musical context, and to maximize the pedagogic values of ear training. Sampled instrument sounds in MP3 format further preserved the fidelity of real instrument sound when compared with the sound synthesized by computer sound cards. The training module required the participants to memorize, recall, and identify four different melodic intervals, namely, perfect fifths (P5), perfect fourths (P4), major sixths (M6) and minor thirds (m3) in both ascending and descending orders. Specifically, this study investigated the effects of (a) Web-based pitch discrimination, and (b) amount of time spent on task, on first-year college music students' achievement in melodic interval discrimination.

The Study

Participants of the study were first-year music majors at a major research university in the United States. Permission to collect data from human participants was obtained from the Institutional Review Board (IRB) at the host institution prior to the commencement of the study. A second Web site was provided to serve as an alternative to Mona Listen. What come as a surprise to the researcher was that even though students were free to choose from either Web site, all students volunteered to sign up with Mona Listen because it offered auto-tracking; should they have chosen the alternative web site, the students were only asked to keep a time log as a record of their access.

A total of 78 first year students, comprised of 34 male and 44 female above 18 years old from the Music Theory I class signed up with the study. Even though all students registered themselves, four of the registrant never login to Mona Listen with their individual ID and password, and were assumed to have withdrawn from the study. From the remainders, 65 completed both pretest and posttest; and out of which, only 62 completed the follow-up posttest also. The follow-up posttest took placed one week after the conclusion of the online data collection, and was meant to measure the post-treatment retention of pitch discrimination skill of the participants in this study.

A panel of music experts reviewed the online training module, Mona Listen, independently and found it to be of high standard. Mona Listen was subsequently field and pilot tested before actual data collection took place in Fall 2003. Participants of the study were asked to treat Mona Listen as if it was a regular online course with a course length of 14 days. Participants must complete a pretest before they were allowed into the training modules proper of Mona Listen, and must complete a posttest after they had completed all the training modules, or by day-14 of the data collection period. Immediately after the posttest, access to the training modules was revoked.

One week later, a pen-and-paper follow-up posttest involving all music students was conducted during one of the regular music lesson, using the classroom piano as the test instrument. The test items used in the pretest, posttest and follow-up posttest were all drawn from a total of sixteen carefully counterbalanced items. These items consisted of melodic intervals in two instrument sounds (piano and guitar) in 4 interval classes (P5, P4, M6 and m3) and two play order (ascending and descending). Participants were randomly assigned to one of two groups for pitch discrimination training of melodic intervals at the point of online registration for the study. One group of participants (N = 31) received training for P5/P4 intervals recorded in piano sound, followed by M6/m3 in guitar sound; and a second, counterbalance, group (N = 34), received training with P5/P4 recorded in guitar sound, followed by M6/m3 in piano sound.

Findings

A reliability coefficient of □□□□ attested to the high inter-item correlation among test items, measured using Cronbach alpha (□□. Statistically significant differences in this study were reported at the α level of 0.05; and the effect sizes of repeated measure studies were reported as partial Eta squared ($\eta p2$) values (Thalheimer & Cook, 2002), in which case the values of .01, .06, and .14 represented small, medium and large effect sizes, respectively (Green, Salkind, & Akey, 2000). The results from this study indicated that technology-enhanced pitch discrimination training was indeed effective. There was a significant improvement in first year college music students' achievement in melodic interval discrimination. Table 1 summarizes the findings in this study.

Table 1: Summary of Research Findings

Research Question	**Findings**
1. "What are the effects of pitch discrimination training in general, and in relationship to prior musical experience?"	Web-based pitch discrimination training had an overall positive effect on first-year college music students' achievement in melodic interval identification. Students with prior music training experience learned melodic interval discrimination at a faster rate than students without prior training.
2. "Does the amount of time spend in Web-based ear training affect participants' pitch discrimination achievement?"	Spending time on pitch discrimination training did bring about an improvement in achievement. However, the amount of time spent was not a good predictor of students' musical achievement. Results suggest other underlying factors, such as musical aptitude, or musical intelligence, might be involved.

The overall finding of the study was highly positive. The main effect for Test showed a statistically significant difference with very large effect size, using an α value of 0.0167 (after Bonferroni adjustment): [$F(2, 60) = 21.284$, $p < .001$, effect size= .415]. The effect size for Posttest1 – Pretest is .38 [$t(65) = 6.269$, $p < .001$], and the effect size for Posttest2 – Pretest is .296 [$t(62) = 5.067$, $p < .001$]. Pre-existing musical ability and prior instrument experience did not appear to produce any significant difference on achievement in melodic interval discrimination training. However, prior music training experience revealed an interaction effect with training [$F(1,63) = 8.555$, $p = .005$, effect size = .12]. It appeared that pitch discrimination training had a stronger positive effect on students with prior music training experience than those who have no prior training experience. Music students with prior musical training were found to learn pitch discrimination at a faster rate than students with no prior training. The prior musical training apparently laid a good foundation to provide support and scaffolding for subsequent pitch discrimination training. There was some indication that players of instruments requiring tuning (including voice majors) were able to discriminate musical pitches better than players of instruments that did not required tuning.

The data analysis employed four within-subject factors, namely Test, Interval, Order, and Instrument. Findings showed several higher-order interaction effects with medium to very large effect size:

- Interval x Order x Instrument ($p < .001$, effect size = .436),
- Test x Order ($p < .01$, effect size = .131), and
- Test x Instrument ($p < .05$, effect size = .073).

Individual main effects thus became irrelevant due to the presence of these higher-order interaction effects. Findings suggest that instrument sound, and play orders of the interval (i.e. ascending or descending) have a significant effect on achievement. Educators must therefore take into consideration these factors when conducting aural training for melodic interval discrimination. Additional research is required to fully investigate the effects of instrument sounds and play orders on pitch discrimination achievement of other musical intervals.

One highly interesting finding from this study was the issue of time-spent on learning. Findings from this study seemed to suggest that spending more time on “learning” (particularly, online learning) might not yield the corresponding anticipated achievement. While spending time on pitch discrimination training did bring about some improvement in pitch discrimination achievement, the amount of time spent on task was not a good predictor of musical achievement.

Finding in this study might help to explain conflicting reports found in the literature concerning the effect of increased training time on achievement, where some reported a positive significant difference (Bauer, 1994; Davis, 2001; Hess, 1995), and others showed no difference at all (e.g. Fortney, 1993; Heritage, 1986; Hess, 1994). Ozeas (1991) reported that although the test score of both “high-score” and “low-score” group would increase after training, participants from the “high-score” group would still outperform the “low-score” group. Consistent with Ozeas’ finding, high-achievers in this study were able to attain higher posttest score means than regular and low-achievers, despite lesser training time. Although lower-achievers were able to increase their posttest achievement score through additional training involving more hours and more rounds of quizzes, they still could not surpass the posttest score means of higher-achievers. Albeit in the case of net training time, there was no significant difference among posttest achievement score means for all participants involved. Post-treatment retention of pitch discrimination skill showed that high-achievers and regular achievers were both able to retain the pitch discrimination skills learned, much more than the lower-achievers. After training was withheld for 7-days, the lower-achievers had nearly reverted to their original state.

Future Recommendations

Other researchers could employ a variety of research methodologies to cross-examine how students learn pitch discrimination in an online environment. Large-scale research work, possibly involving longitudinal studies, would be necessary to fully explore the effects of musical intelligence and music aptitude on musical achievement. Factorial analysis of musical achievement might be useful in helping to uncover deeper underlying issues that affected a person’s pitch discrimination ability. Additionally, instructional gaming had been suggested by (White, 2002) as an innovative mean to relieve the boredom found in repetitive learning tasks such as ear training drills. Future research could incorporate instructional gaming as an alternative mode of delivery for pitch discrimination training.

As new technology such as mobile devices become more accessible, researchers should also consider pitch discrimination or music instruction in a mobile learning environment using wireless personal digital assistants as conduits for accessing online instructional materials for music learning. Researchers are interested in mobile devices, such as the PocketPC, because they could already play Flash documents and MP3 files, in addition to connecting to the Internet wirelessly. However, one should be aware that the Flash player in PocketPC tended to be one version behind than current offering, and might lack certain features as compared to the Flash player for desktop and laptop computers.

Conclusions

Since the 1970s, technology-enhanced pitch discrimination application had long been known to be an effective tool for pitch discrimination training. Compared to CAI, Web-based ear training for pitch discrimination further allows greater flexibility in the areas of accessibility, convenience, content delivery, individualized instruction, and self-paced learning. Additionally, many of the technical obstacles found in the early versions of computer-based music instruction have been overcome through advances in technology.

Although WBMI has many advantages over the older CAI, and is a vibrant growing trend in other subjects of study, there is currently a wide gap in the literature on the use and effects of innovative technology and WBMI at the college level. This study informed the literature by examining the effects of Web-based ear training for pitch discrimination on college music students’ achievement in melodic interval discrimination. Further, the Web-based training module used in this study employed realistic instrument sound to provide not only the musical context for music learning, but also maximize the pedagogic values of ear training for music students aspiring to become professional instrumentalists.

The time has come for an update of pitch discrimination training using current available Internet-related technology. More importantly, new research is necessary for the re-evaluation and verification of pedagogic values of current classroom practices. As music educators seek to improve music pedagogy, researchers of instructional technology can help to innovate by carefully applying instructional design technology principles in technology-enhanced music instruction development. The collaborative research endeavors in WBMI will serve to benefit both academic fields and improve music education, at large.

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