# Comparison of Lecture and Computer-Based Methods for Hearing Conservation Instruction: Implications for Secondary Education

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**Research indicates that children and young adults are at risk for noise-induced hearing loss and can benefit from hearing conservation instruction. The purpose of this study was to examine participant learning about hearing conservation topics, including background information (e.g., anatomy and physiology) and hearing conservation-specific content (e.g., hearing loss prevention), as presented through a lecture vs. a computer-based format and assessed by a 20-point post-instruction exam. The results indicated greater learning of background content for lecture instruction, but no difference between instructional modes for hearing conservation-specific material. These data are discussed in terms of implications for secondary education.**

Research indicates children and young adults in the United States are at risk for noise-induced hearing loss (Holmes, Kaplan, McGahee, Kemker, Weber & Isart, 1997; Niskar, Kieszak, Holmes, Estaban, Rubin & Brody, 2001; Siervogel, Roche, Johnson & Fairman, 1982). Within this population, older children, males, and those living in rural areas are particularly susceptible, as attributed to their greater reported involvement in activities that include firearms, motorcycles, snowmobiles, power tools, fireworks, farm equipment and amplified music (Bess & Poynor, 1974; Catalano & Levin, 1985; Stewart, Scherer & Lehman, 2003). In addition to these home and leisure activities, students may also be exposed to noise in the school setting, including vocational settings, wood and metal shops, music classes, and extracurricular sporting events (Lankford & West, 1993; Lukes & Johnson, 1999; Johnson, Benson & Seaton, 1997).

Given the risks of noise-induced hearing loss for this population, various materials have been developed to support the inclusion of hearing conservation instruction in K-12 education. These include video, CD-ROM, web-based, and printed materials on normal and impaired hearing, auditory anatomy and physiology, noise intensity levels of everyday sounds, the dangers of noise exposure, and the importance of wearing hearing protection. Examples include the “Can’t Hear You Knocking” video (Flynner Films, 1991); the Dangerous Decibels program (Dangerous Decibels, 2006), Hearing Education Awareness for Rockers public service announcements (H.E.A.R., n.d.), auditory demonstration CDs (National Aeronautics and Space Administration Glenn Research Center, 2004; n.d.), the “Wise Ears” program (National Institute on Deafness and Other Communication Disorders, n.d.), and the “Crank it Down” program (National Hearing Conservation Association, 2004).

Studies of hearing conservation education suggest that instructor-led training programs can be effective with children and young adults (Bennett & English, 1999; Chermak, Curtis & Seikel, 1996; Lass, Woodford, Lundeen, Lundeen & Everly-Meyers, 1986; Scrimgeour & Meyer, 2002). Scrimgeour and Meyer (2002) examined the use of a 45-minute educational program incorporating hands-on demonstrations and student participation on young children’s knowledge of auditory anatomy, behaviors and situations potentially hazardous to hearing, and hearing conservation practices. They found improvements in kindergarteners’ knowledge in these areas following participation in the program.

Bennett and English (1999) examined second graders’ understanding of ear anatomy and physiology, normal hearing, and hearing loss prevention following a 1-hour teacher lecture, as compared to student understanding of this content following 1-hour of problem-based instruction. The lecture presentation included a follow-along student workbook and activity packet, videos and equipment demonstrations. The problem-based instruction involved teacher-guided hands-on activities, games, computer demonstrations, and worksheets designed to enhance student learning by way of active investigation and problem-solving. The authors found improvements in the students’ understanding of hearing conservation topics following both lecture and problem-based instruction, with the greatest improvements seen for children in the problem-based learning group.

Chermak et al. (1996) similarly report a significant increase in fourth-grade children’s knowledge of normal auditory function, the effects of noise on hearing, and preventing noise-induced hearing loss associated with hearing conservation instruction. In their study, two 1-hour presentations (by a study investigator) were conducted individually for two classrooms of children. The presentations incorporated hands-on student activities (e.g., disassembling and reassembling a model of the ear), demonstrations (e.g., hearing screening procedures), videos, distribution of written materials, and question-and-answer periods. Additional supplemental activities, designed to be integrated into regular classroom instruction (e.g., creating a poster to educate others about hearing protection) were also made available to the classroom teachers. The findings indicated that both classes of children benefited from the hearing conservation instruction, with those children who received additional teacher-led supplemental activities showing the greatest benefit. Finally, for older students, Lass et al. (1986) found improvements in high school students' knowledge of the effects of noise on hearing following their participation in a hearing conservation educational program that included a film, a lecture and a handout. The topics covered during this program included anatomy and physiology of the auditory system, types and causes of hearing loss, noise and the effects of noise on hearing, and noise-induced hearing loss.

Despite the demonstrated value of hearing conservation education and the availability of materials, this content is typically absent from regular education curricula (Folmer, Griest & Martin, 2002). One possible reason for this absence is that educational audiologists are often supported by special education funds and thus must seek outside support for disability prevention programming for regular education students (Johnson et al., 1997). In addition to posing difficulties for educational audiologists, incorporating non-mandated instruction into an already full academic calendar can be overwhelming to regular education teachers. This may be particularly true if staff access to an educational audiologist is limited and relevant teaching materials (e.g., health textbooks) provide inadequate support (Frager & Kahn, 1988).

An alternative to teacher-led instruction is computer-based instruction, where information is presented to students using computer-based technology (e.g., databases, the internet, CD-ROMs). The use of computer-based instruction in the public schools has risen dramatically in recent years, especially within secondary education (U.S. Department of Education, 2005). By the time they are in high school, students regularly use computers, the internet, and/or personal digital assistants to manage class documents, gather and analyze new information, and complete course projects (Ray, 2003).

Computer applications that are designed for individual learning of hearing conservation material without teacher-led instruction have become increasingly popular and available for occupational settings (e.g., "The Hearing Conservation Training Program;" Interactive Media Communications, n.d.). Such programs are specifically designed to meet the Occupational Safety and Health Administration hearing conservation training requirements regarding noise exposure in the workplace. These computer applications provide users with interactive audio, video, text, and graphics on how the ear works, types and causes of hearing loss, the effects of noise on hearing, and the use of hearing protection.

A similar program for teaching adults about non-occupational noise exposure (i.e., exposure to noise at home, school, and during leisure activities) has been developed at Central Michigan University. This program, called IHEAR ("Interactive Hearing Loss Education and Review;" McDonald, 2004), is an interactive program produced on CD-ROM that uses text, graphics, animation, and sound to present hearing conservation information in four areas of instruction: 1) anatomy and physiology of the ear, 2) hearing and hearing loss, 3) noise and its effects on hearing and general health, and 4) protection from noise-induced hearing loss. The user is able to read text or listen to a narrative (or both) during the presentation of material in each subject area. In addition, the interactive design of the program allows the user to individualize his or her learning experience. For example, users can play video or audio examples when they wish, run simulations as many times as desired, and repeat content at will.

Potential benefits to schools of a computer-based hearing conservation instructional program such as IHEAR include greater flexibility in scheduling instructional time, cost-savings over multiple uses, and enhanced year-to-year and student-to-student continuity. Although children and young adults have been demonstrated to benefit from teacher-led hearing conservation instruction, it is not known whether this is also true for computer-based learning tools such as IHEAR. The purpose of the present study was to compare participant learning about hearing conservation topics, including background information (e.g., anatomy and physiology) and hearing conservation-specific content (e.g., hearing loss prevention), as presented through a lecture vs. a computer-based format (i.e., IHEAR). The goal was to better understand the potential utility of computer-based hearing conservation instruction for young adults regarding non-occupational noise exposure.

## Method

### Participants

Participants in this study were 134 undergraduate students enrolled in a university introductory course on health and wellness (females = 98, males = 36). The university course from which participants were drawn was comprised primarily of freshmen and was open to individuals pursuing any undergraduate degree. Participant sex, ethnic background, and age (over 18 years) were not controlled and participation in the study was voluntary. Participants received extra credit for their health and wellness course upon completion of the study requirements. They were informed that the hearing conservation material taught as part of the study would not be on any course exam, nor would their performance on any study assessment be reflected in their course grade.

### Procedures

Prior to the onset of the study, the research project was explained and interested individuals signed a university Institutional Review Board approved consent form. Participants then completed a 20-item written examination on hearing and hearing loss prevention. This exam represented the pretest evaluation and took approximately 10 minutes to complete. A total of 255 individuals (females = 170, males = 85) agreed to participate in the study and completed the pretest. The pretests were scored, and based on these scores, the participants were divided into two groups (lecture or computer-based instruction) with the goal of matching the two groups' pretest score distributions as evenly as possible (lecture pretest mean = 6.91, SD = 2.04; computer mean = 6.94, SD = 2.11). No other participant variable was utilized in determining instructional group assignment.

One month after completing the pretest, participants were informed of their group assignment and attended either a lecture presentation or a computer-based instructional session on hearing and hearing loss prevention. For both the lecture and computer-based instructional groups, a written 20-item posttest was administered immediately following instruction and was identical to the pretest except for the randomization of items. Following the posttest, participants were asked to answer three survey questions: a rating of their enjoyment of the instruction, their current overall university grade point average, and a self-rating of their computer skills.

Of the 255 original participants, 134 (53%) completed the instruction, the posttest, and the survey questions. These 134 participants were included in the data analyses (lecture group = 82: females = 58, males = 24; computer group = 52: females = 40, males = 12). For these 134 participants, an independent sample t-test of the lecture and computer-based instruction pretest means revealed no significant difference in scores (lecture mean = 7.02, sd = 2.05; computer pretest mean = 7.23, sd = 2.34; p = .538).

**Materials**

Computer-based instruction. Computer-based instruction consisted of participants completing an interactive educational CD-ROM titled "Interactive Hearing loss Education and Review" (IHEAR; McDonald, 2004). IHEAR was designed to provide adults with information about the dangers of loud noise and how to protect one's hearing from excessive noise exposure. The instructional goals of the IHEAR program were to: 1) provide general background information on the structure and function of the auditory system, types of hearing loss, and basic audiometric testing and 2) provide hearing conservation-specific information on types and measurement of noise, the effects of noise on the body, and effective means of hearing protection. To this end, the IHEAR program was designed with four instructional modules. Two of these modules addressed background information, including anatomy and physiology of the ear (module 1) and hearing and hearing loss (module 2). The other two modules addressed hearing conservation topics, including noise and its effects on hearing and general health (module 3) and protection from noise-induced hearing loss (module 4). Each module incorporated text, graphics, animation, and sound, so users could read information, view images, and listen to commentary. Interactive components included pop-up text, animations, and sound-level demonstrations controlled by user mouse clicks.

The computer-based instruction was completed by individual participants in a university computer lab on a walk-in basis over a three-day period. Computer-based instruction was self-paced and not time-limited. Participants were required to begin with instructional module 1, and once it was complete, move to module 2, and so on. No attempt was made to either randomize or counterbalance the order of module presentation. Participants could return to earlier, completed modules but could not move ahead without first navigating to the end of their module. Although the duration of each participant's computer session was not monitored, pilot work during the development of IHEAR indicated the typical session length to be approximately 25 minutes.

Lecture. The lecture consisted of a 25-minute presentation on hearing and hearing loss prevention. The lecture was to the entire lecture participant group on one occasion. The lecture was prepared using the goals and materials of the IHEAR program. For the lecture, these goals were accomplished by way of an oral presentation, supplemented by PowerPoint text and image slides. Participants were allowed to ask questions at any point during the presentation, and a question-and-answer period was provided at the end of the lecture. Few participants availed themselves of these opportunities.

Pretest and posttest examinations. The written examination used for the pretest and the posttest was developed by the authors for the purposes of the present study (Appendix A). The examination included eight background information questions on anatomy and physiology of the auditory system, types of hearing loss, and audiometric assessment (i.e., "background"), and 12 questions specifically addressing noise, the effects of noise on hearing and general health, and noise protection (i.e., "hearing conservation"). The exam items were reviewed by three audiologists prior to their use, who verified their appropriateness for the project. In addition, five individuals who were not familiar with hearing conservation issues and who were not associated with the study were asked to complete the examination to confirm that the correct multiple choice answers were not intuitively obvious to respondents. Finally, the exam was designed with enough difficulty to avoid the likelihood of a ceiling effect.

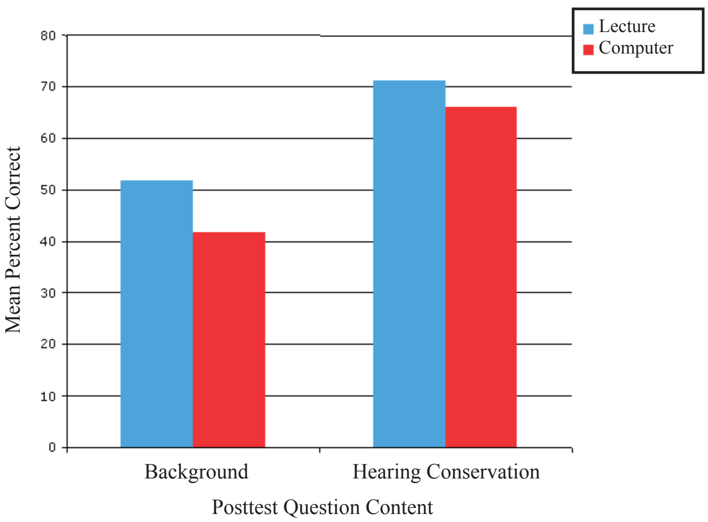
**Results**

For both lecture-based and computer-based instructional groups, paired samples t-tests indicated that posttest scores were significantly higher than pretest scores for background, hearing conservation, and overall scores (see Table 1). Figure 1 shows the mean percent correct for both lecture and computer groups on background (8 questions) and hearing conservation (12 questions) posttest questions. An independent samples t-test of lecture and computer group posttest means indicated that the mean posttest score for the lecture group was significantly greater than that of the computer group (lecture = 12.70, sd = 2.96; computer = 11.25, sd = 2.54; $t_{132} = 2.91$, p = .004). Independent sample t-tests of lecture and computer group posttest means indicated that while the mean background information posttest score for the lecture group was significantly greater than that of the computer group (lecture = 4.15, SD = 1.68; computer = 3.33, SD = 1.29; $t_{132} = 3.00$, p = .003), the lecture and computer groups did not differ on hearing conservation posttest questions (lecture = 8.55, SD = 2.01; computer = 7.92, SD = 1.81; $t_{132} = 1.83$, p = .07).

**Table 1. Mean pretest and posttest scores (sd) for the lecture (n = 82) and computer-based (n = 52) instructional groups.**

| Variable | Pretest (sd) | Posttest (sd) | statistic | p |
|---|---|---|---|---|
| Background | | | | |
| Lecture | 2.37 (1.44) | 4.15 (1.68) | $t_{81}$ = 9.10 | <.001 |
| Computer | 2.46 (1.32) | 3.33 (1.29) | $t_{51}$ = 3.88 | <.001 |
| Hearing Conservation | | | | |
| Lecture | 4.66 (1.44) | 8.55 (2.01) | $t_{81}$ = 15.40 | <.001 |
| Computer | 4.77 (1.72) | 7.92 (1.81) | $t_{51}$ = 9.24 | <.001 |
| Overall | | | | |
| Lecture | 7.02 (2.05) | 12.70 (2.96) | $t_{81}$ = 16.46 | <.001 |
| Computer | 7.23 (2.34) | 11.25 (2.54) | $t_{51}$ = 9.29 | <.001 |

**Figure 1. Mean percent correct posttest background and hearing conservation scores for the lecture and computer groups.**




Three post-hoc analyses of variance were performed to investigate the effects of: 1) enjoyment of instruction, 2) grade point average, and 3) computer skills on participant performance in both the lecture-based and computer-based instructional conditions. When asked to rate their enjoyment of the instruction they received, less than half of each group responded positively (enjoyment of lecture: low = 57%, high = 43%; enjoyment of computer-based instruction: low = 60%, high = 40%). Table 2 includes the mean posttest scores of respondents who indicated either low or high enjoyment of their training. An analysis of variance indicated that the main effect of instructional mode was significant ($F_{1,130}$ = 8.54, p = .004), which is consistent with the t-test reported previously. The main effect of enjoyment ($F_{1,130}$ = .001, p = .979) and the instructional mode by enjoyment interaction ($F_{1,130}$ = .234, p = .629) were not significant.

**Table 2. Summary of a univariate two-way analysis of variance of posttest scores (out of 20) for instructional mode and participant enjoyment.**

| Variable | n | Mean | sd | statistic | p |
|---|---|---|---|---|---|
| Instructional Mode | | | | $F_{1,130}$ = 8.54 | .004 |
| Lecture | 82 | 12.70 | 2.96 | | |
| Computer | 52 | 11.25 | 2.54 | | |
| Enjoyment | | | | $F_{1,130}$ = .001 | .979 |
| Low | 78 | 12.10 | 2.89 | | |
| High | 56 | 12.17 | 2.90 | | |
| Instructional Mode x Enjoyment | | | | $F_{1,130}$ = .234 | .629 |
| Lecture Low | 47 | 12.60 | 3.20 | | |
| Lecture High | 35 | 12.83 | 2.65 | | |
| Computer Low | 31 | 11.35 | 2.18 | | |
| Computer High | 21 | 11.10 | 3.03 | | |

In reporting their overall university grade point average (GPA), roughly one-third of each instructional group indicated a GPA equivalent to either a "C" or below, one-third a "B," and one-third an "A" (lecture = 31%, 43%, 27%; computer = 33%, 37%, 31%; "C" or below, "B," and "A," respectively). Table 3 includes the mean posttest scores of respondents based on GPA. A two-way ANOVA indicated a significant main effect for GPA ($F_{2,128}$ = 9.05, p < .001). Post-hoc analyses indicated that students who reported an overall GPA of C or lower had significantly poorer posttest scores than the B or A students, while the B and A students were not different from one another. The ANOVA again indicated a significant effect for instructional mode ($F_{2,128}$ = 10.34, p = .002). A nonsignificant instructional mode by GPA interaction ($F_{2,128}$ = .80, p = .453) was also obtained.

**Table 3. Summary of a univariate two-way analysis of variance of posttest scores (out of 20) for instructional mode and participant self-reported Grade Point Average (GPA).**

| Variable | n | Mean | sd | statistic | p |
|---|---|---|---|---|---|
| Instructional Mode | | | | $F_{1,128}$ = 10.34 | .002 |
| Lecture | 82 | 12.70 | 2.96 | | |
| Computer | 52 | 11.25 | 2.54 | | |
| GPA | | | | $F_{2,128}$ = 9.05 | <.001 |
| <=C | 42 | 10.78 | 2.54 | | |
| B | 54 | 12.37 | 2.46 | | |
| A | 38 | 13.28 | 3.23 | | |
| Instructional Mode x GPA | | | | $F_{2,128}$ = .80 | .453 |
| Lecture <=C | 25 | 11.48 | 2.50 | | |
| Lecture B | 35 | 12.63 | 2.65 | | |
| Lecture A | 22 | 14.18 | 3.36 | | |
| Computer <=C | 17 | 9.76 | 2.31 | | |
| Computer B | 19 | 11.89 | 2.08 | | |
| Computer A | 16 | 12.06 | 2.69 | | |

When asked to report their self-perceived computer skills, 20% of the lecture and 15% of the computer groups indicated low skills, 63% of the lecture and 62% of the computer group indicated moderate-to-good skills, and 17% of the lecture and 23% of the computer participants indicated high computer skills. Table 4 shows the posttest performance for both instructional groups and for groups based on self-perceived computer skills. An ANOVA revealed a significant main effect for computer skills ($F_{2,128}$ = 4.68, p = .011), with students who reported high skills performing better on the posttest than did those who reported either moderate-to-good or low computer skills. Posttest scores for respondents who indicated low or moderate-to-good computer skills did not differ. The ANOVA again showed a main effect for instructional mode ($F_{2,128}$ = 4.63, p = .033). The instructional format by computer skills interaction was not significant ($F_{2,128}$ = .65, p = .525).

**Table 4. Summary of a univariate two-way analysis of variance of posttest scores (out of 20) for instructional mode and participant self-reported computer skills.**

| Variable | n | Mean | sd | statistic | p |
|---|---|---|---|---|---|
| Instructional Mode | | | | $F_{1,128}$ = 4.63 | .033 |
| Lecture | 82 | 12.70 | 2.96 | | |
| Computer | 52 | 11.25 | 2.54 | | |
| Computer Skills | | | | $F_{2,128}$ = 4.68 | .011 |
| Low | 24 | 11.71 | 2.97 | | |
| Mod-Good | 84 | 11.83 | 2.71 | | |
| High | 26 | 13.50 | 3.06 | | |
| Instructional Mode x Computer Skills | | | | $F_{2,128}$ = .65 | .525 |
| Lecture Low | 16 | 11.88 | 3.34 | | |
| Lecture Mod-Good | 52 | 12.58 | 2.72 | | |
| Lecture High | 14 | 14.07 | 3.15 | | |
| Computer Low | 8 | 11.38 | 2.20 | | |
| Computer Mod-Good | 32 | 10.63 | 2.24 | | |
| Computer High | 12 | 12.83 | 2.95 | | |

## Discussion

The results of the present study showed that both lecture and computer-based instruction were effective in increasing participant knowledge. When considering posttest scores overall, participants who learned via lecture-based instruction performed better than those who learned by way of computer-based instruction. This result is perhaps not particularly surprising, given that secondary and post-secondary students are accustomed to acquiring knowledge in this manner. However, when separately considering posttest performance for background and hearing conservation information, the data of the present study indicated that background information was better learned through a lecture format, while information related to hearing conservation was acquired through lecture or computer instruction equally well. The results further indicated that learning was not related to participants' level of enjoyment of the instruction, but was directly related to overall academic success (as indicated by GPA) and self-reported computer skills, regardless of instructional format.

One possibility of why background information was better acquired through lecture than computer instruction is that these concepts were more difficult to understand and participants benefited from the guidance and attention of a live instructor. As may be seen by Figure 1, mean percent correct scores were generally lower for background information, suggesting that participants did find this material more difficult. The relatively greater success of the lecture participants in learning this background material may have been due to the more flexible and responsive nature of a live instructor vs. a fixed computer program. Even within a large group, an effective lecturer can gauge the reactions of the audience to new information and provide repetition and clarification as necessary. In the present study's computer-based instruction, although the content was equivalent to that presented in lecture, the format was relatively fixed and participant-directed repetition was strictly reduplicative. Thus, it may be that the computer participants needed but did not have additional instructional support for understanding the background concepts, support that was available to the lecture participants.

Another possible reason why background information was better acquired through lecture is that in a live presentation, it is the responsibility of the instructor to ensure that all of the target content is taught, regardless of the perceived relevance of that material to the learner. In contrast, with the present study's computer-based instruction, content delivery was controlled by the user. Thus, the computer participants may have moved through the modules on background material relatively quickly because this information did not seem as relevant to the instructional topic as the hearing conservation-specific modules. The lecture participants, on the other hand, did not directly control the pace of instruction and thus were guaranteed a certain depth and breadth of exposure to this content, regardless of perceived relevance of the material.

An alternative to these explanations is that performance differences were not related to the difficulty or relevance of background and noise-specific content inherently, but the design and delivery of the instructional materials specific to the present study. For example, it may be that the lecturer used for the present study was a more engaging presenter for background material but lost her audience when discussing noise and hearing protection. This may not be true for another instructor. Similarly, it may be that the specific CD-ROM used for the computer-based instruction of the present study was for some reason less user-friendly or less attractive to users in the background modules than the hearing-conservation specific modules, but that another similarly designed CD-ROM would not show such a distinction. Finally, an order effect may have contributed to the background and noise-specific differences observed in this study. Since noise-specific information was taught after background information, it is possible that this prior exposure somehow increased the participants' abilities to learn the noise-specific information. Further research with additional instructional materials or study designs that control order of content presentation is needed to explore these issues.

Overall, the findings of the present study indicate that both lecture and computer-based instruction are effective in increasing young adults' knowledge of hearing conservation-related concepts. Specifically, the findings indicate that background information may be better learned through a lecture format, while information related to hearing conservation may be acquired through either lecture or computer instruction. These data suggest that one effective way to teach hearing conservation in the secondary setting would be for classroom teachers to lecture on anatomy and physiology of the ear, normal hearing, hearing loss, and measurement of hearing sensitivity, followed by students completing interactive computer-based modules on noise level measurement, the effects of noise on hearing and general health, and protection from noise-induced hearing loss. This instruction could be integrated into one or more classes such as biology, health, or physics. The role(s) of the educational audiologist in this scenario could include direct teaching, teacher inservicing, providing slides and lecture notes, and recommending computer applications.

However, since the data of the present study indicate that neither mode of instruction was entirely effective (although test difficulty and/or student motivation may have contributed to poor scores), supplemental instructional approaches to enhance learning should be considered. One approach for secondary education would be to support classroom lecture and computer-based instruction with experiential or problem-based learning activities such as students screening hearing sensitivity, measuring noise levels in multiple environments, or discovering the effectiveness of various hearing protection devices (Bennett & English, 1999; Chermak, et. al, 1996; Naeve-Velguth, Hariprasad, & Lehman, 2003; see Johnson, et. al, 1998 for a list of materials). Such supplemental activities could stem naturally from computer-based instruction in that for both, students are required to work and think relatively independently. Additional work in this area could include the expansion of interactive modules to include greater numbers of virtual hands-on experiences (e.g., virtual 3D models of the ear that can be assembled and disassembled) and the integration of computer-based technology with real-world applications of knowledge (e.g., high school students producing a hearing conservation PSA for local elementary schools).

In summary, the results of this study suggest that the use of computer-based instruction is a viable method for providing young adults with hearing conservation information. In addition to the methodological concerns discussed above, future research could include assessing the effectiveness of IHEAR within the secondary classroom, developing and testing a multi-year curriculum, and examining teacher receptivity to incorporating hearing conservation instruction into the curriculum. This research may help to identify which modes of instruction are most beneficial for student learning as well as practical for real-world classrooms.

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## Appendix A

1. Excessive noise causes damage to what part of the ear? *
    a. Damages the hearing nerve
    b. Damages hair cells in the inner ear
    c. Damages the bones in the middle ear
    d. Damages the hair cells in the middle ear

2. What frequency range is most affected by a hearing loss caused by noise? *
    a. Low frequencies
    b. Middle frequencies
    c. High frequencies
    d. They are all affected equally

3. Normal conversational speech is how loud? *
    a. 30 dB
    b. 45 dB
    c. 60 dB
    d. 80 dB

4. The hearing nerve is what cranial nerve? **
    a. III
    b. V
    c. VII
    d. VIII

5. A hearing loss resulting from an abnormality within the inner ear or hearing nerve is called: **
    a. Conductive hearing loss
    b. Sensorineural hearing loss
    c. Mixed hearing loss
    d. Inner ear hearing loss

6. OSHA requires that hearing protection be offered if loudness levels exceed what for an 8 hour time period? *
    a. 75 dB
    b. 85 dB
    c. 95 dB
    d. 100 dB

7. The loudness of an airplane is: *
    a. 95 dB
    b. 115 dB
    c. 140 dB
    d. 170 dB

8. A hearing loss that occurs for only a short time is called: *
    a. Short term hearing loss
    b. Temporary threshold shift
    c. Minimal hearing loss
    d. Periodic hearing loss

9. The most important speech sounds contain information in what frequency range? **
    a. Low and mid frequency
    b. Mid and high frequency
    c. Mid frequency information
    d. High frequency

10. Exposure to noise can cause all the following except: *
    a. Increased blood pressure
    b. Fatigue
    c. Increased heart rate
    d. Increased cholesterol

11. A hearing loss caused by noise is called what? *
    a. Noise-induced hearing loss
    b. Exposure hearing loss
    c. Conductive hearing loss
    d. Loudness induced hearing loss

12. Which is NOT a bone of the middle ear? **
    a. Incus
    b. Malleus
    c. Stapes
    d. Cochlea

13. Hearing loss is plotted on a/an: **
    a. Hearing graph
    b. Audibility graph
    c. Hearinggram
    d. Audiogram

14. Tinnitus is: *
    a. Ear ache
    b. Itching in the ear
    c. Ringing in the ear
    d. High frequency hearing loss

15. The occlusion effect is: *
    a. Talking louder after you leave a noisy place
    b. A plugged feeling from water in your ears
    c. Your own voice having a base-like quality
    d. Ringing in your ears

16. Hearing levels for the right ear are represented by: **
    a. A square
    b. An “X”
    c. A triangle
    d. A circle

17. The hair cells in the inner ear rest on: **
    a. the Tectorial membrane
    b. Reissner’s membrane
    c. basilar membrane
    d. cochlear membrane

18. Tinnitus can be affected by the following: *
    a. Medications
    b. Caffeine
    c. Alcohol
    d. A and C
    e. All of the above

19. Which is NOT a method of measuring noise in the workplace? *
    a. Noise sampling
    b. T-BEAM
    c. Personal dosimetry
    d. Area sampling

20. A profound hearing loss is a loss of ___ or greater: **
    a. 80
    b. 90
    c. 100
    d. 110

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* Hearing conservation specific items (e.g., noise, the effects of noise on hearing and general health, and noise protection).

** Background items (e.g., anatomy and physiology of the auditory system, types of hearing loss, and audiometric assessment).