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Short Communication

Multimedia for Occupational Safety and Health Training: A Pilot Study Examining a Multimedia Learning Theory

Erik S. WALLEN* and Karen B. MULLOY

Department of Internal Medicine, University of New Mexico, MSC10-5550, Albuquerque, NM 87131, USA

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Abstract: Occupational diseases are a significant problem affecting public health. Safety training is an important method of preventing occupational illness. Training is increasingly being delivered by computer although theories of learning from computer-based multimedia have been tested almost entirely on college students. This study was designed to determine whether these theories might also be applied to safety training applications for working adults. Participants viewed either computer-based multimedia respirator use training with concurrent narration, narration prior to the animation, or unrelated safety training. Participants then took a five-item transfer test which measured their ability to use their knowledge in new and creative ways. Participants who viewed the computer-based multimedia trainings both did significantly better than the control group on the transfer test. The results of this pilot study suggest that design guidelines developed for younger learners may be effective for training workers in occupational safety and health although more investigation is needed.

Key words: Multimedia, Adult learning, Training, Computer-based learning, Occupational health and safety

Occupational asthma is a significant and increasing problem in the workplace. In the United States, respiratory illnesses account for 7.5% of all fatal occupational illnesses. This constitutes a serious public health problem. The Occupational Safety and Health Administration (OSHA) has mandated that employers in the United States provide yearly training for workers who are required to use respirators in the workplace. Interventions, including training, are a cornerstone in the primary prevention of occupational illnesses. The National Institute for Occupational Safety and Health (NIOSH) has identified intervention effectiveness as one of its priorities in the National Occupational Research Agenda (NORA). The goal of intervention effectiveness research is to demonstrate the impact of interventions, such as education. Many training methods, including computer-based training methods, have not been fully investigated.

Health and safety training is increasingly being delivered by computer. There are several potential advantages to computer-based training (CBT) including cost-effectiveness and the potential for greater learning resulting from interactivity.

Previous studies of learning from multimedia have shown that it can also be a powerful means to enhance learning. Unfortunately, most of the previous studies examining learning from multimedia have been done using relatively young and well-educated college students as participants. Older learners can differ in important ways from younger learners including their ability to comprehend new information and their levels of computer anxiety. The differences between younger and older learners could result in important differences in how younger and older people interact with computers. Because of the increased use of computer-based training for working adults, it is important to test multimedia learning theories on older subjects to ensure that they are valid for use with this group. In this pilot study, the applicability of computer-based multimedia learning theories, previously tested only on younger learners, is examined for working adults.
The thirteen subjects in the pilot-study were maintenance workers at a large Southwestern University (mean age 42.9, standard deviation 7.9). These workers had received yearly classroom-based, didactic lecture respirator training yearly as part of their job requirements. Prior training occasionally included pictures as part of the lecture, including pictures of respirators.

Subjects were recruited by sign-up sheets in their department and were paid $25 for their participation. Multimedia instructional materials were developed which covered some of the health and safety aspects of respirator use including how filters and cartridges work, why a proper fit and seal for the respirator is important, how to perform positive and negative pressure fit tests, and why facial hair can interfere with a good seal. These topics were chosen because they form a core of knowledge for understanding how to use a respirator and are components required by OSHA regulations. Each of these topics included pictures or animations to help the subjects visualize the mechanisms. For instance, Fig. 1 shows two screen shots from the animation describing how filters work. In the upper panel, air is moving through the filter but dust is being caught. In the lower panel, dust is still being caught but the other hazard—a chemical fume—is passing through the filter. This animation is intended to develop the learner’s model of how filters work and its limitations. Eight animations were used which together totaled about 2.5 min.

The subjects were randomly assigned to one of three groups (four ended up in groups CN and NF and five in group NA). Group NA viewed multimedia instruction with concurrent narration and animation. In addition, all other instructional text was narrated. The instructional time for group NA was approximately 14 min. Group NF viewed the same animations with narration played first. All other text was narrated concurrently with the pictures on the screen. The instruction for group NF was approximately 16.5 min. The control group (CN) viewed unrelated multimedia instruction on preventing slips and falls. The instruction consisted of a narration that played concurrently with pictures and videos and lasted approximately 15 min. Learning time for all groups was not restricted and learners could take as much time as they needed and had the opportunity to watch the narrated animations as many times as they wished.

After randomization, each worker completed an English literacy test and a test of visual aptitude. Subjects then viewed the computer-based multimedia training.

Upon completion of the computer-based multimedia instruction, subjects were given a posttest designed to assess their knowledge of respirator safety. The posttest was designed to test for high-level learning and transfer of knowledge by requiring subjects to problem solve and respond to “real-life” situations with creative solutions. For instance, one question gave subjects the following scenario: “You and a co-worker are working in a room with painters. You are both wearing respirators. Your co-worker says that he smells solvent. Write down everything that could be wrong.” This test was scored by counting the total number of correct answers to a list of all possible correct answers. This type of question is thought to be a good predictor of whether learners will be able to transfer their newly acquired knowledge and use it outside of the learning setting. The posttest contained five items and participants were given as much time as they needed to complete it.

An ANOVA was calculated on the results of the transfer test ($F_{2,10}=6.017$, $p<.05$). Because the ANOVA was
significant. Fisher’s PLSD post-hoc tests were calculated which revealed that both the group that received concurrent narration and animation (NA, mean=10.0, \( p < .05 \)) and the group that received the narration prior to the animation (NF, mean=11.2, \( p < .05 \)) group scored significantly better on the transfer test than the control group (mean=6.25).

The results of this study indicate that multimedia instruction utilizing coordinated visual and verbal presentations may be an effective means of training workers in occupational safety and health. Participants in the group that received concurrent visual and verbal information scored significantly higher on the transfer test than did participants in the control group. These results are noteworthy because the subjects were not naive learners. Most learning experiments use naive learners who have little or no knowledge of the subject matter. The participants in this study had received yearly training covering the same material that was delivered in the computer-based multimedia training.

Many of the studies examining learning from multimedia are based on Dual Coding theory\(^{13}\), which posits that humans possess two distinct processing systems, one for visual and one for verbal information. When information is presented so that the visual and verbal information is presented contiguously, learners have a better opportunity to build connections between visual and verbal information in long-term memory. These connections between visual and verbal information result in better memory for the subject.

In a study of dual coding theory in computer-based multimedia instruction, Mayer and Anderson\(^{14}\) presented college students with narrated animations showing how brake systems and bicycle pumps work. They presented the instruction either as concurrent animations and narrations or with successive presentations of narrations and animations. They found that these groups did not differ in their ability to answer recall questions but that the group that received the concurrent animations and narrations did significantly better on a transfer test that required them to use their newly acquired knowledge in new and creative ways. The present study differs from the Mayer and Anderson study in several important ways including the length of the instructional treatment (about 3 min for the Mayer and Anderson study) and the numbers of concepts the learners were taught. The Mayer and Anderson study focused on instruction of one single concept while the current study focused on five important concepts for using respirators.

The results of this study were in general accord with the results of experiments using college students as subjects. This suggests that some of the multimedia guidelines developed using younger learners will be useful for the design of computer-based instruction in occupational health and safety including avoiding overloading the learners’ cognitive system by presenting animations and narrations in a non-concurrent manner\(^{15}\). However, the high, and unexpected, scores of the group that received narrations prior to animations indicate that there may be important differences between working populations and college age subjects in learning from multimedia. Research that examines reasons for these differences and that examines the best methods for utilizing multimedia-based training need to be expanded.

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References


