EDUCATIONAL MULTIMEDIA: A TEST OF DUAL-CODING THEORY

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ABSTRACT

An experiment was conducted to examine how dual-coding theory would operate in a computer-mediated learning task. The findings confirmed that modality can change the outcome predicted by dual-coding theory. Participants who received narration performed as well as participants who received on-line text. Participants who did not receive the text devised an ad hoc mechanism (taking notes) for adjusting the level of information available to them.

INTRODUCTION

Classrooms throughout the world today have students using computers to incorporate technology into their educational environment. This study hopes to contribute to the analysis and evaluation of educational technology use in one domain, that of multiple simultaneous media uses. Although we focus on the educational setting, this study has implications for corporate learning environments, too. Educational technology is also changing in light of the newer faster and cheaper computers that are available on the market. Technology is being used to create virtual environments in educational settings. As multimedia teaching becomes more prevalent, especially in connection with distance learning initiatives, some researchers have begun to examine the relationships between cognitive learning and technology. In general, studies report that advanced technologies that combined both a verbal and visual approach to presenting information is beneficial to student's learning (Welsh & Null, 1991). Virtual learning environments have become popular methods of teaching science, medicine, history and high risk skills where conducting hands on learning could be too expensive, too dangerous, or simply impossible (Schank & Cleary, 1996). In a virtual learning environment learners are taken out of their physical environments and transported to other places or times. A virtual environment is generated from sights, sounds, and physical sensation (Winn, 1995). These elements can lead to a rich learning environment.

Despite the growth in educational technology use, there is a lack of research on the design and develop technology for computer assisted learning (Mayer, 1994). While developing instructional technology, instructional designers and teachers should be asking themselves whether combining different modalities can increase a student's understanding while learning subject matter using computer-assisted instruction. Another related question involves determining the best modalities for computer-assisted instruction. Dual-coding Theory can be a useful tool in examining these questions.

DUAL-CODING THEORY

Paivio's Dual-Code Theory (DCT) claims that there are two cognitive subsystems. One, specializes in the representations of verbal intake, such as language, while the other, specializes in non-verbal intake, such as objects (Paivio, 1986). According to this construct, DCT is the result of both the auditory and visual nature of the processing capabilities of the human brain. In DCT one is to understand that mental representations are associated with two symbolic modes. DCT is grounded in research that found human memory is much better if one can develop mental images for verbal material. For example, if a student is asked to remember the sentence, The children played outside, the student would be much more successful in recalling the sentence for the teacher if the student had a mental picture or activity that went along with the verbal sentence. A picture showing children playing outside would be ideal; therefore, students would have the mental model correspond with the verbal code.

A verbal system, according to Paivio (1991) includes visual, auditory or articulatory codes. Words, like codes are symbols that represent objects, as well as abstract ideas. For example: representations for words such as wall, bag, shelf, book, and even ideas such as worry all stimulate codes for the learner. Nonverbal representations can include shapes, sounds, kinesthetic actions, emotions, or other non-verbal events.

DUAL-CODING THEORY STUDIES

Mayer (2001) has studied the traditional DCT associated with verbal and nonverbal codes, nonverbal codes almost always being images or animation. Mayer and Anderson (1992) conducted research that presented the contiguity principle, which states that the effectiveness of multimedia instruction will increase by presenting words and pictures continuously, rather than in an isolated way. Mayer and Anderson (1992) found that animation and/or pictures did not improve a student's understanding of a household repair. The study led Mayer and Anderson to hypothesize that presenting narration and animation concurrently encourages the learner to make connections and support problem solving transfer.

Mayer and Sims (1994) concluded that inexperienced students were better able to transfer what they had learned about a scientific system when visual and verbal explanations were presented concurrently than when visual and verbal explanations were separated. More recently, Beacham, et al. (2002) conducted a research study that investigated whether or not different media combinations influenced a student's understanding of computer based learning material. Results indicated that using sound and visual enhanced participant's understanding.

IMPORTANCE OF MODALITY

Mayer and Moreno (1998) tested a dual-processing theory of working memory. The presumption was that visual information is first processed in visual working memory and auditory information is first processed in auditory working memory. Therefore, modality does matter because working memory can become overloaded if too much information is given at one time. Given that each working memory has limited capacity, learning could be inhibited. The researchers also

concluded that the benefit of presenting words and corresponding pictures at the same time will depend on the modality of the words (Mayer, 1999).

Presno (1997) concluded that Bruner's (1966) three forms of representation (action, pictures, and words and numbers) could be successfully applied to virtual learning environments. Presno notes that there are instances where a learner needs to perform a task to fully comprehend how to do it. Schank and Cleary (1996) concluded that kinesthetic activity should not be neglected when using computer assisted instruction.

Simpson (1994) suggested that Paivio's dual-coding theory does not take into account the variable abilities of people to process information. His stated that the younger a learner is, the more likely they are to process information better in one modality or another and that presenting two or more modalities at one time can serve to confuse a learner. He believed that images were the strongest modality for young learners and as learners age they are able to develop complimentary verbal abilities.

Many studies support Paivio's dual-coding theory in relationship to multimedia learning. But as technology continues to develop and robust virtual learning environments are created, the question of modality effects becomes important. Thus the focus of the present experiment examines the outcome of college student's ability to learn MS Word Mail Merge with verbal and non-verbal instruction vs. non-verbal instruction only.

EXPERIMENTAL STUDY

In this study, students viewed a computer lesson depicting the steps needed to successful create a mail merge letter us MS Microsoft Word with concurrent narration (Group 1) or with concurrent on-screen text (Group 2). According to the dual processing hypothesis, Group 1 should perform better than Group 2 and be able to recall relevant steps in creating a MS Microsoft Word document.

METHOD

The participants were 32 college students recruited from the School of Business Administration at the University of San Diego. All participants indicated that they lacked experience in MS Word and had never conducted a mail merge prior to the experiment. Seventeen students in Group 1 the concurrent narration group and 15 students served in Group 2 the concurrent on-screen text.

Each student was asked to fill out a questionnaire prior to watching a video tutorial that taught how to use Microsoft Word Mail Merge. The questionnaire included the following statements: "I know how to do a Word Mail Merge," "I can find a the tools for a Word Mail Merge on the Toolbar," "I can make a database for a Word Mail Merge," "I can use an already made database for a Word Mail Merge," "I can merge form letters by using Word Mail Merge," and "I can merge envelops by using Word Mail Merge." A retention test contained the following instructions at the top of the sheet: "Please explain the steps needed to perform a mail merge."

The computerized portion of the study consisted of an on-line tutorial video. The computer based instructional video explained in detail the basics of MS Word Mail Merge. The transfer test

consisted of a basic MS Word Mail Merge database placed on the participant's desktop, and with the instructions to complete the mail merge in 6 minutes.

Participants were given the questionnaire prior to watching the computer based instructional video. Group 1 watched with computer based instructional video, which included concurrent narration describing each of the major events in words spoken at a slow rate by a male voice. Group 2 included concurrent text presented on the screen using the same words and timing as Group 1. The animation was created by the university's computing services department. Each participant was equipped with headphones so that the sound of one computer did not interfere with another participant's experiment.

First, participants completed the participant questionnaire and were told to work at their own rates. Second, the experimenter presented oral instructions stating that the computer would show a video of how to use MS Word Mail Merge and when the video was over students would then be given another questionnaire to complete. Participants in Group 1 were told to put on headphones, and all participants were told to start the on-line instructional video. Third, after participants started the video, participants in Group 1 were presented the video with concurrent narration, while Group 2 was presented the video with concurrent text. Fourth, when the video was finished the experimenter presented the participants the same questionnaire and asked the participants to complete it. Fifth, the participants were told to complete the MS Word Mail Merge document that had been placed on their computer's desktop. Participants were told they had 6 minutes to complete the mail merge.

RESULTS

Prior to the video, participants were asked if they knew how to do a mail merge, all participants responded that they did not. The dual processing hypothesis states that students should recall more material when it is presented verbally rather than in text form. Prior to the on-line educational video all participants stated that they did not know how to conduct a mail merge. Of the 15 participants in Group 1, 100% felt they were able to conduct a mail merge after viewing the video with concurrent narration. Of the 17 participants in Group 2, 15 out of 17 felt they were able to conduct a mail merge after watching the video with concurrent text. When presented with the retention test, 13 out of 15, (86%) participants in Group 1 were able to perform a mail merge. Group 2, 14 out of 17, (82%) were able to conduct a mail merge. Overall, there was not a significant difference between the concurrent narration and the concurrent text.

DISCUSSION

Although prior research would indicate that students learn best when presented with visual material accompanied by verbal information, our results would indicate that this is not the case. During the course of the study two additional unplanned observations were made. First, participants who were presented with visual and text concurrently took notes on the back of their questionnaires. More than half the participants in Group 2 had notes. In Group 1 only five participants took notes. Participants were not told to take notes. Also, participants who took notes tended to rely on the notes when recalling the information to conduct a mail merge. One possible reason for this would be that

participants who knew they were not going to have sound concurrent with the visual felt they had to work harder to retain the information. Thus, they took notes to assist them in the recall portion of the experiment. Some participants were asked why they took notes during the video and they responded that always take notes.

Second, in a debriefing session conducted after the experiment, 12 of 15 participants indicated that they preferred learning on-line. They believed that on-line learning was easier and could be done at their own pace. Our three main findings include: (1) Sound is not necessary in teaching basic computer skills if the program being used is simple to follow and direct in it visual direction; (2) Learners tend to use other methods of understanding a computer tutorial if there is no sound, for example, taking notes; and (3) An on-line computer tutorial can be an effective way to teach students basic computer skills.

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