How do different components of multimedia affect learning?

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Multimedia is composed of various components: text, illustrations/animation, and audio. These components can contribute differentially to the learning of material. Paivio's Dual Coding Theory (1971), where the learning of material is enhanced by the simultaneous development and activation of verbal and visual codes, can be applied to multimedia learning (Mayer & Gallini, 1990). However most empirical work to examine this theory has focused on illustrations and text. Therefore, the studies described in this paper focus on all three components of multimedia with the goal of determining the contribution that these components have on learning.

Experiment 1 tested whether different components would result in different amounts of learning using a multimedia training program in optics. A pre-test-train-post-test procedure was used. Subjects first received a spatial abilities test, then were given a pre-test in optics. After training, subjects received a post-test. The multimedia training in optics either presented audio alone, text alone, pictures and animation (visuals) alone, audio plus text, audio plus visuals, text plus visuals, and all three of the components together. The control group used a genetics tutoring system. Results indicated that two components were better than a single component. However, a different learning outcome is measured depending upon which component is added.

In Experiment 1 some of the components such as animation and audio were presented separately. For example, subjects in the audio, text and animation condition first saw the text on the screen with the audio, then saw the animation, and then finally saw the text screen again. They could replay the audio and replay the animation. However, only the text and audio occurred concurrently. Thus, the static illustration of the animation would be available during the playing of the audio but the audio was not available during the playing of the animation. This method may not have been as effective as presenting the animation, audio and text all at once (Mayer & Sims, 1994). Therefore, Experiment 2 was designed to examine whether concurrent presentation would make a difference for this type of material (optics).

Experiment 2 used the same procedure and materials as Experiment 1 with the following exceptions: only audio plus visuals and audio, visuals and text conditions were tested, and two new conditions with audio playing concurrently with visuals were added. Results indicated that for all three components, concurrently playing the audio had little effect. On the other hand, audio playing concurrently with visuals when only two components were playing resulted in slightly better learning.

In summary, two or three components were better than a single one; however, audio and text were not as effective as audio and illustrations or text and illustrations. Three components were not better than two components. Consistent with Mayer and Sims (1994), concurrent presentation for audio and visual components was better than presenting the components separately; however, no benefit was found for concurrent presentation when all three components were present. Thus, in both experiments, three components were not a vast improvement over two components.

These results do not uniformly support the Dual Coding Theory. In support of the theory, adding an overlapping verbal code (as evidenced by adding audio to text plus graphics or text to audio plus graphics) was not as beneficial. On the other hand, the theory is not as well supported by the data for two components. The Dual Coding Theory predicts that adding a verbal form to a non-verbal form should produce much higher increases than merely repeating the verbal form in a different modality. Although adding graphics/animation to verbal information increased learning from the material, using both types of verbal material together (audio with text) also caused increased learning. As suggested earlier, an audio presentation of text along with the written text format may provide prosodic cues along with the benefit of a decrease in working memory load to enable better performance than either a written text alone or an audio alone condition. Further, adding graphics did not have the same effect on both types of verbal information (graphics to text or graphics to audio). (Note that the increase for adding text or audio to the graphics may have been limited by a ceiling effect.) Thus, a modality effect is suggested by these data.

Although the larger question about whether more than one component is better was not hard to determine, these results may not be generalizable across different types of multimedia. However, it should be noted that this task, learning about optics, was a visually-oriented task and therefore an additional constraint on examining learning through multimedia may be the topic. In fact, different types of multimedia may have different types of learning results (Lee et al., 1996). Therefore, considering both the type of material to be learned and what components might enhance or degrade learning performance should be considered when developing multimedia.