Literature Review: The Safe and Proper Use of Wrenches: An Instructional Video

David E. Croft

University of Hawai‘i at Manoa

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“The promise of multimedia learning – that is, promoting student understanding by mixing words and pictures – depends on designing multimedia instructional messages in ways that are consistent with how people learn” (Mayer, 2003). How does the learner process multimedia information? Does animation impact learning, and if so, in what ways? Is multimedia inherently able to facilitate learning or is design critical? Can multimedia motivate and engage, and if so, under what conditions? Can the “promise of multimedia learning” be realized by an instructional video in an Automotive Technology class for high school students? This literature review will attempt to provide insight into these questions.

Multimedia Learning Theory and its Implications for Design

By the early 1980’s, the behaviorist model of learning, which emphasizes stimulus-response, started to be replaced by the cognitive model, which focuses upon mental events (Saettler, 1990). In the cognitive model, the key components are the organization, processing and storage of information by the learner (Saettler, 1990). The information processing theory, which incorporates the metaphor of the computer, centers upon the manner in which information is stored in memory. Januszewski and Molinda (2008) citing Atkinson and Shiffrin’s research, state that information transitions from sensory memory, to short term memory, to long term memory.

It is from the cognitive perspective that Mayer formulated a theory of multimedia learning, and suggested its implications for multimedia design. Mayer (Lowe & Schnotz, 2008) formulated his multimedia learning theory based upon three major ideas from cognitive learning theory: dual channels, limited capacity and generative processing.

**Dual Channel Assumption**

The dual channel assumption is based upon the fact that sensory information is introduced to the nervous system from external stimuli, essentially auditory and visual stimuli.
Two separate channels, auditory and visual, gather and process data through the eyes or ears (Mayer, 2003). This assumption is based upon the research of Paivio and Baddley (Lowe & Schnottz, 2008).

**Limited Cognitive Capacity Assumption**

It is assumed by Mayer (Lowe & Schnottz, 2008) that there is a limit to the amount of visual and auditory data that can be processed at any given time before either or both channels become overloaded. Mayer based this assumption upon the research of Baddley, Chandler and Sweller (Lowe & Schnottz, 2008).

**Processing Assumption**

There are three types of cognitive processing: extraneous processing, which pertains to processing that is not directly connected to the instructional goal; essential processing which consists of basic processing that is pertinent to the learning objective, for example, choosing words and images and beginning to organize them; and generative processing, which refers to integrating the relevant material (Mayer, 2001; Lowe & Schnottz, 2008). In generative processing, learners actively select and organize relevant auditory and visual data from the dual channels into coherent models, integrating them with related prior knowledge so that meaningful learning occurs (Lowe & Schnottz, 2008). The process takes place when the auditory and visual data are in working memory at the same time (Lowe & Schnottz, 2008).

**Extraneous Processing**

processing that is not directly connected to the learning objective, needs to be reduced in order to preserve enough cognitive capacity for the learner to integrate and process the essentials of the lesson (Paas, Renkl & Sweller, 2003).

According to Mayer (Lowe & Schnottz, 2008), there are five ways to reduce extraneous overload in multimedia lessons: coherence, signaling, redundancy, spatial contiguity and
temporal contiguity.

*Coherence.* The coherence principle indicates that individuals learn more effectively when extraneous information is avoided, due to the limitations of cognitive load (Mayer & Jackson, 2005; Moreno & Mayer, 2000).

*Signaling.* The signaling principle refers to another means of reducing extraneous load by giving cues or signals to the learner regarding the importance and organization of the information being presented (Mautone & Mayer, 2001). The use of cues such as “first, second and third,” and tone of voice serve to highlight important points for the learner, which in turn enables them to better process the key information.

*Redundancy.* The redundancy principle refers to the need to create a video lesson in which the narration is presented simultaneously with the animation. The animation can then be processed in the visual channel while the narration is processed in the auditory channel. The narration should not be accompanied by on-screen text because that creates extraneous overload (Moreno & Mayer, 2002).

*Spatial contiguity.* The spatial contiguity principle indicates that printed words should be positioned next to the related part of the animation. This reduces visual scanning and avoids extraneous overload (Moreno & Mayer, 1999).

*Temporal contiguity.* The temporal contiguity principle means that individuals learn more successfully, when animation and narration are simultaneous, instead of following one another (Mayer & Anderson, 1992).

**Essential Processing**

During the essential processing phase, which is the initial processing pertinent to the multimedia lesson, processing overload may occur and must be reduced (Lowe & Schnotz, 2008). This may be accomplished by applying three principles: the segmenting principle, the pre-
training principle and the modality principle (Lowe & Shnotz, 2008). The segmenting principle refers to presenting an animation in segments, which can be viewed by the individual learner at his or her own pace. The pre-training principle indicates that individuals learn more successfully when they have been previously introduced to the names and major characteristics of the main components (Mayer, Mathias & Wetzel, 2002). The modality principle indicates that individuals learn more successfully when animation and narration are presented together, as opposed to presenting animation with on-screen text (Mayer & Moreno, 1999; Moreno & Mayer, 2002). This is beneficial because the auditory channel processes verbal expressions, while the visual channel processes the animation, thus reducing the visual load. When on-screen text is presented, the visual load is increased unnecessarily.

Generative Processing

refers to choosing pertinent parts of the animation and narration, organizing those pertinent portions into mental models, and integrating them with each other, as well as with previously acquired knowledge (Lowe & Schnotz, 2008). Lowe and Schnotz cite Reeves and Nass, from 1996, in pointing out that generative processing is more likely to occur when there is a perception of a social partnership between the learner and the computer based instructional lesson. To establish such a social partnership, Lowe and Schnotz advocate using an informal conversational style to personalize the video lesson. As the Mayer, Fennell, Farmer and Campbell (2004) discussion stated, “...if personalized versions encourage additional constructive processing – such as organizing and integrating the material – then personalized versions should create their greatest effects on measures of transfer.” Lowe and Schnotz (2008) also advocate using a human voice as opposed to a machine voice.

Further Implications for Multimedia Design Elements

Research indicates that the visual element in animation has many interrelated factors that
need to be addressed: still images, motion/animation, contrast, text and color. Prior knowledge may also affect learner outcome while watching animation. It has been found that novice students benefit from still graphics with regard to learning descriptive, as well as procedural knowledge, because learners with low domain-general knowledge may not be able to distinguish the most relevant features of the image/animation from those that are visually obvious but not key to the concepts being presented (ChanLin, 2001). Experienced students benefit from animation because they are better able to identify salient visual information (ChanLin, 2001). Lowe (2003) conducted research using meteorology lessons, which supports this finding. Highlighting or arrows can be used to direct learners’ attention appropriately (Lowe & Schnozt, 2008). Still imagery and motion/animated imagery require that special attention to visual contrast be taken.

“According to PowerPoint presentation consultant Geetesh Bajaj, most people's favorite presentation background color is blue. Bajaj recommends using dark blue backgrounds with white or yellow text” (Brier & Lebbin, 2009). This particular piece of the puzzle is critical for contrast between any text that may be applied, and its background. The video itself will use as much contrast as possible to emphasis important points, but it will also have text that will need to standout as well.

The rule of thirds is considered a basic rule of visual composition (Scharf, 2006). This rule places important visual information in specific areas of the screen, thus enabling the viewer to see the information quickly. But, what motivates the learner to want to view the information at all?

Motivation

Clark’s (1998) model of motivation suggests that three types of values influence the degree of engagement in an activity: utility, interest, and importance.
Utility and Importance

Automotive technology should have a certain amount of inherent utility and importance to secondary students because generally one of their goals is to operate and maintain a vehicle, and a rudimentary understanding of Automotive Technology enables them to perform basic maintenance and converse effectively with mechanics, thus making them more effective in their increasing pursuit of independence.

Interest

The interest factor of the motivational equation must also be considered. How best to maintain student interest and make a lesson appealing? A modified hybrid on-line/face-to-face format for a Technology Education course, also known as Industrial Arts, appears to be the most appropriate for a hands-on environment (Lorenzetti, 2004), and is supported by findings that the hybrid course, featuring face-to-face instruction was the most preferred among students (El Mansour & Mupinga, 2007). Motivating a target audience of secondary education students who are often “Digital Natives” is a continual challenge. Students are frequently accustomed to accessing the information they need, as they need it and tailoring it to suit their needs. Many are able to customize their informal learning environments due to their familiarity with technology such as iPods, cell phones that access the Internet, and Blackberries. In their home environment, they are continually exposed to, and actively seek, a variety of media that employ graphics and video. Formal learning strategies should also offer a variety of media, and some means of customizing it, to engage these tech savvy students. Customizing an instructional module, to enable the student to set his or her own pace through the module, also contributes to student engagement. The creation of chapters for the video will provide students an opportunity to freeze, rewind or jump to areas of interest or need.
Conclusion

Animation is not a panacea. As Goldman points out, (Lowe & Schnottz, 2008) it is an oversimplification to assume that any new technology or material will be inherently beneficial in terms of learning outcomes. The characteristics of an effective learning environment must be examined. A review of the literature provides support for the value of multimedia as an effective instructional tool, under some conditions and provided certain design elements are used. Further research, especially in the content area of Industrial Arts, is needed.
Reference


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