SDPS-2013
Printed in the United States of America, October, 2013

APPLICATION OF MULTIMEDIA PRINCIPLES FOR SELECTION OF VIDEO TO ENHANCE STUDENT ENGAGEMENT AND LEARNING

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ABSTRACT

Increasing availability in the classroom of online multimedia and technology infrastructure (e.g., availability of web access, wireless infrastructure, projectors, digital smartboards, etc.) broadens options for instructional strategies to enhance student engagement and learning. A number of reviews have emphasized the importance of student attention as a prerequisite for learning, and of multimedia as an important tool for stimulating student engagement. Results from research in sensory input and cognitive processing lead Clark and Mayer (2011) to construct principles for guiding the design and evaluation of multimedia for enhancing learning. We apply some of these principles to evaluate online video for potential use in the classroom to enhance student engagement and learning.

INTRODUCTION

Importance of Digital Video in Higher Education

The uses of digital video (*multimedia*, as this medium typically consists of some combination of moving visual, graphic, textual, and auditory information) in science cannot be underestimated today, and students destined for STEM (Science, Technology, Engineering and Mathematics) careers will be increasingly exposed to digital video products throughout their education and professional life. With the increasing deployment within educational institutions of hardware, software, and computer networks, the ability of an instructor to incorporate multimedia resources into the classroom environment has dramatically increased. For example, although one might presume that a high percentage of videos on YouTube, the world's largest video archive, has little pedagogic value, the fact that Google has recently established YouTube EDU, a repository for educational video, is recognition of a market for videos of educational value. From a number of recent surveys about the importance and use of video in higher education (Kaufman and Mohan, 2009; Moran et al., 2011), the following generalizations emerge.

- Online video is by far the most common type of social media used in the classroom,
- YouTube is the dominant online source for, and having the greatest value of, video used in the classroom, and
- faculty expect to use more online video in teaching.

DISCUSSION

Growth of Online Video and Use in the Academic Environment

The explosive growth of online video, especially in YouTube, makes possible the extensive use of video for enhancing classroom teaching (provided, of course, that the necessary equipment and Internet access is available).

The current generation of college students has grown up in a technologically saturated environment, and consequently, many students have different expectations and patterns of media consumption (Oblinger and Oblinger, 2005). One of the many characteristic differences noted is "attentional deployment", the ability to rapidly shift focus, and a "fast response" time, the expectation of a rapid pace for information delivery with a commensurate reaction, which Prensky (1998) calls "twitch speed". However, for a reassessment of the perceived "common sense" understanding of "digital natives", see Kontropoulos (2011). In any case, newer products packaged with science texts (e.g., W.H.Freeman eLearning, n.d.; Cengage Learning, n.d.), are produced in shorter lengths, providing more numerous opportunities for observation, analysis, and discussion.

The increasing use of classroom video means that faculty are displacing former minutes of teaching by other means to accommodate this digital medium. What are some reasons that faculty find greater value in classroom time utilized by the viewing and discussing of video, compared to the former classroom environment without video? In a major study, the National Research Council Committee on Undergraduate Science Education identified research results that document more effective teaching practices engage students in reflection and the testing of ideas during classroom discussion (NRC, 2003, in Henderson et. al., 2010; also see National Research Council, 2012). Video snips in the classroom enable opportunities to enhance student learning because of multiple sensory inputs (e.g., audio, visual, textual) and the ability of multimedia to tell a compelling story in an immersive experience (Berk, 2009-2012; Moving Image Collections, 2003). The richness of sensory cues in multimedia in online courses was particularly important in building a sense of community and active learning, according to Adams (2006). Video snips provide opportunities for reflection, analysis, synthesis, and discussion as directed by the instructor, and are powerful drivers of student learning, according to Miller (2009, 2011), Osteen et al. (2011), Snelson (2010), and Streeter (2011).

Components of Active Learning and Alternative Presentation Medium

Experts in the cognitive science of multimedia learning, such as Clark and Mayer (2011) and Sorden (2012), recognize a number of components of what is called "active learning". Students must 1) first engage or attend to relevant information, 2) organize that relevant information in meaningful ways, and finally 3) integrate that meaningful information in ways that build upon the learner's prior knowledge.

Digital video is an appropriate medium through which these active learning components may be appropriately deployed. For example, an instructor of a basic science course might first introduce students to the importance of critical thinking in science, and the various skills of science that help us to become better observers and interpreters of data.

A typical treatment of this information in text form on a PowerPoint slide is shown in Fig. 1. In lecture, the instructor would normally "discuss" [in many cases, unfortunately, "read"] this information while it is onscreen. As many of us recognize when we are in the audience of a professional presentation delivered through PowerPoint, we can, and do, read the onscreen slide text much faster than the speaker narrates, thus creating a temporal disconnect between the speaker and audience.

An alternative presentation as multimedia with much the same information can been seen in this video snip - http://www.ezsnips.com/vD1ANG52aeTS3

A comparison of similarity of content and differences in the medium (static PowerPoint slide vs. video animation and narration) makes clear the potential of multimedia for enhancing student engagement, understanding of concepts, and broadening relationships between science and other disciplines.

Clark and Mayer Model for Multimedia Channels

Clark and Mayer (2011) propose a theoretical model of sensory and information channels and their properties to explain and guide the design and deployment of multimedia to enhance learning opportunities. Postulates of this model include the following.

- humans exhibit separate channels for processing visual and auditory sensory information,
- the capacity of these channels is limited, and a channel can be overloaded, and
- by recognizing these limitations, we can make intelligent decisions that reduce cognitive loads and engage learners in the active processes that enhance opportunities for learning.

Fig. 2 illustrates a part of Clark and Mayer's (2011) dual channel model of multimedia learning. Auditory and visual sensory input are routed through ears and eyes, respectively, and then passed to a short-term memory system, where sound and image information is first organized before longer-term memories are constructed, stored, and eventually integrated with new input (not shown). Although Clark and Mayer (2011) classify different types of demands on cognitive processing capacity, we note that there are numerous points in the pathways of cognitive processing where a student may not "keep up" with the flow of information, and thereby encounter impediments to learning. Examples of cognitive overload are presented below.

Principles and Application of Multimedia Design for Learning

Clark and Mayer (2011) summarize a number of principles that may be used to guide and/or evaluate the design of multimedia. We will discuss a few examples and then apply these principles to evaluate the suitability of some online multimedia for the classroom.

Principle of spatial contiguity: It is almost by common sense that text labels that identify parts in an image ought to be placed adjacent to those parts, rather than further way. Notice in Fig. 3a the placement of labels detached and removed away from their referring parts. A better placement of labels is shown in Fig. 3b.

Principle of temporal contiguity: Within a video, text labels that identify parts ought to appear at the same time as, and adjacent to, the part to which they refer, rather than before or after. An example of a video to which this principle may be applied may be viewed at http://ezsnips.com/C4k810DJvSnCb
Notice at about 0:15 to 0:20 seconds, labels that identify the type of soil or rock appear within the layer to which each label refers, in accordance with the principle of spatial (and temporal) contiguity. However, beginning at about 0:27 seconds through 0:32 seconds, the label "Moisture Saturates Ground" appears over the limestone rock layer at the bottom of the animation, while a darkened tone is applied and moved down through the layers from the top of the soil, thus violating the principle of spatial contiguity. A better solution would have been to place the label "Moisture Saturates Ground" over the moving front that indicates this phenomenon.

Principle of coherence: The principle of coherence asserts that students learn better when extraneous (irrelevant) material is excluded from the (relevant) multimedia. In other words, “Less is More”. For example, this principle may be applied to a collection of different colors (fewer is better), labels (fewer is better), and placement (uncluttered is better).

When a graphical illustration is used to convey detailed information, the higher density of text and graphics may begin to interfere with a student’s ability to recognize the important information around which the illustration is designed. For example, in Fig. 4a the illustrator appears to have designed the high-density graphic to substitute for the factual content of a textbook. An alternative graphic, Fig. 4b, exhibits important relationships fundamental to the conceptual principles on which the graphic is based. The less cluttered and lower density of labeled text directs student attention to these conceptual fundamentals. “Less is More” applies here.

The principle of coherence may be applied to video multimedia. For example, a video may include a soundtrack of “background” music at the same time as the display of some animation or video. The coherence principle asserts that unless explicitly coordinated and designed to add necessary information, the background soundtrack is irrelevant to learning, and therefore is distracting. Adherence to the principle of coherence in multimedia learning may require the muting of the background soundtrack.

Distractions caused by conflicting, multiple sensory channel inputs are found in some video with “background” music tracks. For example, watch this video snip - http://www.ezsnips.com/MVmmbxXkAEeb3
The sound track is distracting both in its volume and its rhythm, especially when playing simultaneously with the animated presentation of text. Furthermore, the soundtrack content in this video is irrelevant – it adds no new information to the animated text and graphics. The inclusion of the soundtrack thus violates the principle of coherence, and it should be muted.

Principle of modality – the principle of modality asserts that students learn better from video with narration than from video with onscreen printed text (e.g., captions, boxed text, or text crawl). Why should this be so? To read onscreen text during a video, our eyes must jump back and forth from the printed matter to the video image, because both printed text and image require visual input (Fig. 5a). Cognitive load in the visual channel is increased by competition for sensory input and processing resources. As a consequence, the visual working memory system may become overtaxed. One strategy to enhance learning is to reduce the cognitive load in the visual channel by omitting the onscreen printed text, and instead convey this information by narration through the auditory channel so that parallel (but separate) processing of visual and auditory input may occur (Fig. 5b).

The modality principle therefore recommends that a video presentation should present a narration track without a caption crawl. (This principle assumes that the audience is composed of learners without sensory impairment, such as a deaf student who needs a caption crawl for reading). For an example of this presentation format, watch this video –
https://www.youtube.com/watch?v=girMtlUi-TA
When it begins to play, click the “CC” (closed caption) symbol to turn on the caption crawl. Then watch the video a second time with the closed caption crawl turned off. It is more difficult to attend to the caption text while trying to simultaneously listen to the audio narration and also watch the graphic motion of the video. Because our eyes cannot attend to two different locations at the same time, the bottom of the screen with the caption crawl, competition increases for resources in the visual channel and working memory (Fig. 5b).

Principle of redundancy – the principle of redundancy asserts that the simultaneous presentation of onscreen text (visual) that duplicates narration (auditory) presents the potential for overload in the visual channel and working memory (Fig. 6), especially during a rapid pace of new and unfamiliar material. Because onscreen text must be read at the same time as whatever other graphical display is present, the viewer cannot at the same time attend visually to two separately located displays of information. A resolution to enhance the potential for student learning is to omit the onscreen text. The new information is then conveyed as narration input through the separate auditory channel (Fig. 5b).

CONCLUSIONS

Although the vast majority of video stored online in the YouTube repository was not produced specifically for pedagogical purposes, we have found hundreds of videos with suitable subject-specific content (e.g., earth science) that exhibit characteristics generally consistent with principles of multimedia as espoused by Clark and Mayer (2011). These principles appear to be an adequate primary filter for selecting online video for further evaluation prior to use in a classroom environment. The use of video multimedia filtered for concordance with principles of multimedia learning and pedagogic value may potentially enhance the learning environment and ultimately improve student performance.

ACKNOWLEDGEMENTS

We wish to thank David Graves, UAB chemistry department chair, for encouragement of this research and access to resources, the UAB Research Foundation for encouragement in the development of EZSnips (pat. applied for) and in granting exclusive license to us, and to the Economic Development Partnership of Alabama (EDPA) for its hosting of the Alabama Launchpad startup competition and selection of EZSnips as a finalist in the class of 2011-12.

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FIGURES AND TABLES

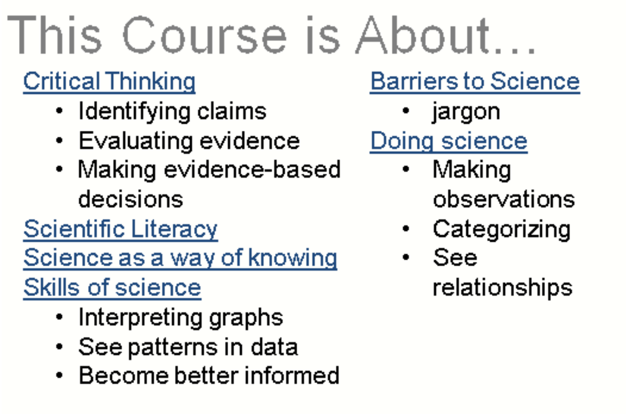

Fig. 1 A PowerPoint slide representative of a text-heavy style designed to convey factual information

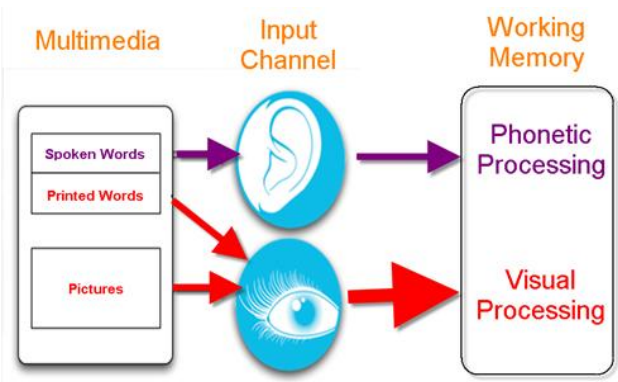

Fig. 2 A portion of Clark and Mayer's (2011) model of multimedia learning, incorporating two channels of sensory input and short-term (working) memory

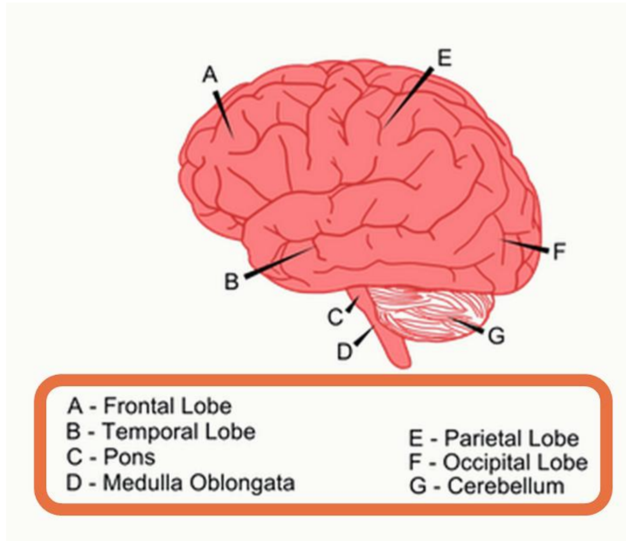

Fig. 3a An illustration showing a violation of the principle of spatial contiguity because the labels are disconnected and removed from the parts to which they refer

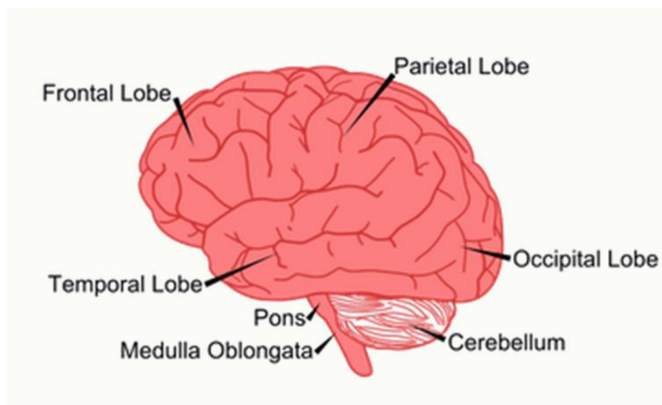

Fig. 3b A revised illustration correcting the violation of the principle of spatial contiguity by the contiguous placement and connection of the labels to the parts to which they refer

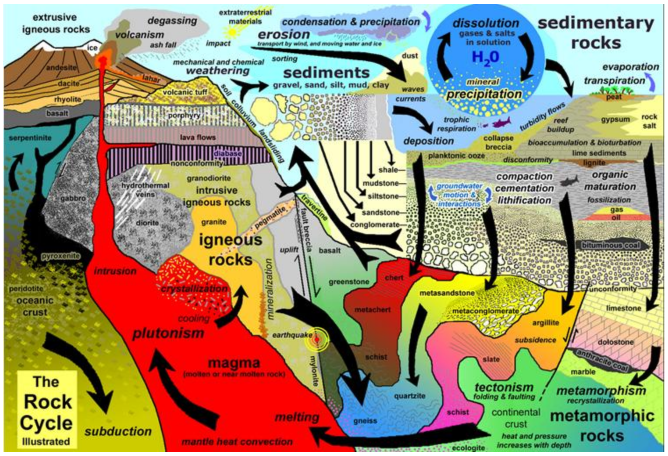

Fig. 4a An illustration showing a violation of the principle of coherence because of the cluttered nature, small font text, and high density placement of labels

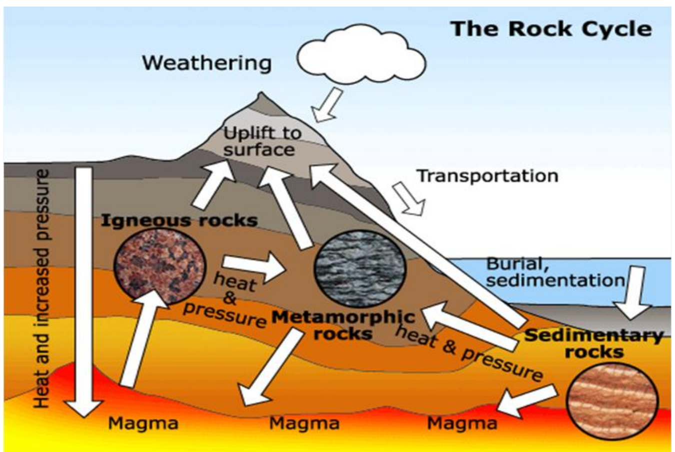

Fig. 4b A revised illustration showing corrections to the violation of the principle of coherence by lowering the density, increasing the font size, and uncluttering the labels

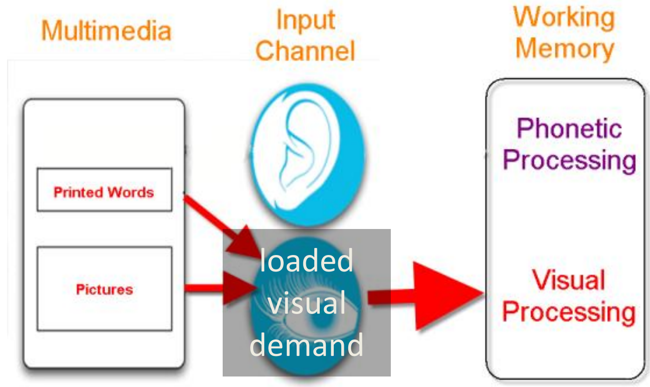

Fig. 5a An illustration showing a violation of the principle of modality because the onscreen printed text and visual graphics have the potential to overload the visual input channel and working memory.

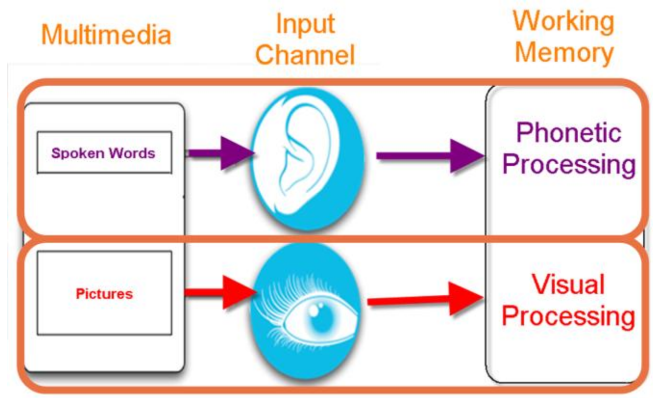

Fig. 5b An illustration showing that the omission of onscreen printed text would unload the visual channel by substituting a narration of the same information which passes through the auditory channel instead

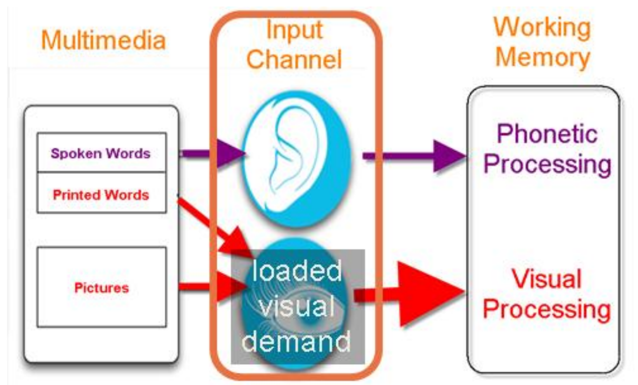

Fig. 6 An illustration showing a violation of the principle of redundancy because the same information, onscreen text and narration, are presented respectively through the visual and auditory channels.