Cognitive Theory of Multimedia Learning

The Assumptions of Multimedia Learning

Today in education, there is an enormous potential for optimizing learning and instruction. Increased reliance on technology, combined with how the brain processes information around it, has become an extreme interest to educators (BrainPOP, 2008). The Cognitive Theory of Multimedia Learning, from Richard Mayer of the University of California, can be used to guide instructional technologists in the creation of more effective computer-based training and multimedia instruction.

The Cognitive Theory of Multimedia Learning describes the cognitive process that occur when exposed to multimedia learning (Moreno & Mayer, 2008). The theory is based on three assumptions (http://www.learning-theories.com/cognitive-theory-of-multimedia-learning-mayer.html). The first assumption is that two separate channels for processing information exist. The channels are auditory and visual. Within the dual-channel assumption, people use separate channels to process visual and auditory information independently (Jin-Hua et al., 2009). Using both of the auditory and visual channels, student learning through multimedia instruction can be dramatically enhanced as information is presented. This occurs because the brain accommodates more new information by taking advantage of its multimodal processing capability with technology-based tools (BrainPOP, 2008).

Within the second assumption, both auditory and visual channels are recognized to have a limited capacity. Within this limited-capacity assumption, people can process only a limited amount of information simultaneously on each channel (Sorden, 2005). Continuing to expose a person to information in an already filled capacity, will only hinder the learning process. The final assumption is that learning itself is an active process of filtering, selecting, organizing, and integrating information (http://www.learning-theories.com/cognitive-theory-of-multimedia-learning-mayer.html). Within the active-processing assumption, people engage in active learning by paying attention to relevant incoming information, organizing selected information into coherent mental representations, and integrating mental representations with other knowledge (Jin-Hua et al., 2009).

Working Memory and Cognitive Overload

The brain can learn an unlimited amount of information. How the brain processes information affects what it keeps and recalls. New information is taken to working memory, the post-it note area of the brain, for processing. Working memory has a capacity limit after four to seven new It accomplishes this through a system of subcomponents that holds temporary information and processes it so that several pieces of verbal or visual information could be stored and integrated (Sorden, 2005).

From the perspective of an instructional technologist, the concept of working memory that is most significant is the amount of information and ways that can be processed (Sorden, 2005). In today's educational environment, instructional presentations are often accompanied by a liberal use of multimedia that is intended to engage and add excitement to the lesson and hold the learner's attention. Because of working memory's limits to taking in information, these visual and auditory components do not always make for sound instructional design in their delivery and can quickly become counter-productive to learning (Sorden, 2005). Given that we only have a very limited amount of information processing capacity in working memory at any single moment, instructional designers should not be seduced into filling up limited capacity with unimportant or flashy instruction in a multimedia presentation (Sorden, 2005). Therefore, multimedia content should exclude extraneous and redundant information, because learning is most effective when interesting and irrelevant information is eliminated due to the brain's limited information processing resources. Extraneous information is a detriment to learning (BrainPOP, 2008).

Cognitive Load Theory is concerned with a learner's cognitive resources that are focused and used during learning and problem solving. For instruction to be effective, it is critical to design instruction in a way that does not overload the mind's capacity for processing information (Sorden, 2005). While using multiple channels can increase the amount of information that the brain can process, there is a risk of cognitive overload. Too much information delivered in an ineffective manner can interfere with the brain's ability to successfully integrate information into long term memory (BrainPOP, 2008). Long-term memory itself organizes information into meaningful chunks called schema. Presenting information in a way that makes use of existing organizing structures (schema), or that helps students organize information in their mind, can greatly assist the learner in incorporating information into Long Term memory (BrainPOP, 2008).

Instructional Technology and Multimedia Learning

Through the multimodal processing capability of the brain and technology-based tools, instructional technologists can dramatically enhance student learning through multimedia instruction. Good multimedia instruction is driven by an understanding of how the brain processes information. The most effective multimedia applications take advantage of this knowledge and recognize that working memory has a limited capacity to process information. Instructional technologists should therefore consider multiple strategies in their multimedia design.

Instructional Technology and Presentations (BrainPOP, 2008):

- Effective multimedia presentations take advantage of both the auditory and visual channels in working memory to deliver content.
- Text heavy multimedia presentations may be less effective than those that rely on narration.
- Learners of integrated information presentations outperform learners studying the same information where attention is split.
- Multimedia presentations are more effective when the learner has the ability to interact with the presentation, by slowing it down or by starting and stopping it.
- Presentations should be segmented; shorter segments that allow users to select segments at their own pace work better than longer segments that offer less control.
- Presentations that are conversational in tone tend to be more engaging than those that have a more formal tone.
- Learners find presentations that use a familiar voice with a familiar accent more engaging than those that use a less familiar voice and accent.

Instructional Technology and Text (BrainPOP, 2008):

- Text may be particularly challenging to process, and requires involvement from both the visual and auditory channels.
- People learn better from words and pictures than from words alone. Words would include written and spoken text, and pictures would include static graphic images, animation and video. This is because words and pictures allow the brain to process more information in working memory.
- Text and pictures presented in close proximity or overlapping are more effective than those applications that present text and pictures far apart on the screen.

Instructional Technology and the Auditory and Visual channels (BrainPOP, 2008):

- The visual channel handles less information than the auditory channel.
- When information is presented using both the visual and auditory channels, working memory can handle more information overall.
- By using multiple channels of working memory, multimedia content can increase the likelihood that information will be effectively integrated into long term memory and not lost.

Instructional Technology and Narration and Video (BrainPOP, 2008):

- Narration and video is much more effective than narration and text.
- Narration and video also appear to be more effective than narration, video and text.
- Narration and text rely on the same channel to process information
- Narration and animation presented together are more likely to contribute to student learning than the presentation of narration and then animation (or animation and then narration).

Instructional Technology and Animated Content (BrainPOP, 2008):

- Multimedia instruction that includes animation can improve learning when used effectively.
- Learning is enhanced in computer-based animation environments
- Animation appears to be most effective when presenting concepts or information that students may have difficulty by helping them visualize a process or other dynamic phenomenon that cannot be envisioned easily.
- By enabling students to visualize complex information, animation can make it easier for the learner to make sense of the information in a way that requires less processing.
- Animation is more likely to be effective if it is accompanied by narration, which combined makes use of both the auditory and visual channels.

Instructional Technology and Learners (BrainPOP, 2008):

- Multimedia learning is more effective to learning when it is interactive and under the control of the learner. When learners are able to control the pace of the presentation, they can learn more.
- Knowledge activation can be accomplished by allowing students to preview the content though demonstrations, discussion, directed recall and written descriptions. Preview activities should be directed at activating prior knowledge.
- Multimedia learning is most effective when the learner is engaged as engagement helps the student construct knowledge and organize information into meaningful schema.
- Personalized multimedia engages learners more than multimedia that is less personalized (Mayer, 2005a).
- Use of onscreen characters can increase student engagement, particularly when the character interacts with the learner.
- Presenting educational concepts in a story-based format can be effective in engaging students.
- Multimedia is most likely to be effective when students are provided with opportunities to apply what they have learned following exposure as it reinforces and strengthens the newly acquired knowledge.
- Multimedia learning is most effective when the learner can apply their newly acquired knowledge and receive feedback, as it helps keep students informed about their progress and stay engaged.
- Multimedia applications are more effective when learner attention is not split and the learner is forced to attend to information that is far apart, such as when content is visually far apart on the screen or if it is presented at two separate points in time.

References

BrainPOP (2008). Understanding multimedia learning: Integrating multimedia in the K-12 classroom. Retrieved from http://www.brainpop.com/educators/community/wpcontent/uploads/2014/02/120618_BrainPOP_White_Paper.pdf

Jin-Hua, S., Chun, W., Hui, W., & Shumei, C. (2009). Design of an e-Learning system for technical Chinese courses using cognitive theory of multimedia learning. *Electronics & Communications in Japan*, *92*(8), 1-10. doi:10.1002/ecj.10204

Mayer, R.E. (2005). The Cambridge Handbook of Multimedia Learning. New York: Cambridge University Press.

Moreno R, Mayer R.E. (2008). A learner-centered approach to multimedia explanations: Deriving instructional design principles from cognitive theory. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning*, *2*(2).

Sorden, S.D. (2005) A cognitive approach to instructional design for multimedia learning. *Informing Science Journal,* 8, 263-279.