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MULTIMEDIA PRINCIPLE IN TEACHING LESSONS

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Abstract. Multimedia learning principle occurs when we create mental representations from combining text and relevant graphics into lessons. This article discusses the learning advantages that result from adding multimedia learning principle into instructions; and how to select graphics that support learning. There is a balance that instructional designers have to keep in mind when using multimedia principle; adding multimedia principle to lessons ought to depend on the knowledge level of the learners. We should also consider when to use static or dynamic graphics; what the communication functions of each graphic are and which types of Graphics are appropriate for each of the different instructional goals.

Keywords: Multimedia, Instruction, graphics, lessons, Active Learning, Teaching

Introduction

In teaching, it is normal to use printed or spoken words as the primary way for conveying information. Words are simple, easy and cheap to utilize. Then again do learners learn better when graphic organizers are added to text? This article examines whether there is any benefit on supplementing words with multimedia. Specifically, do learners learn more from words and graphics, which include static graphics such as drawings or photos or dynamic graphics like animation or video, than from words alone? The term multimedia refers to presentations that contain both words and graphics.

There are strong and reliable evidence that learners obtain more knowledge from words and graphics than from words alone. Many researches confirm this evidence; Richard Mayer was a pioneer in examining the effects of multimedia on learners. In 1989, Mayer argued that multimedia supports the way the human brain learns efficiently. Many additional research has confirmed and recommend using multimedia-words and graphics, rather than words alone in teaching; research have been documented by Mayer & Anderson in 1991 and 1992; Mayer, Bove, Bryman, Mars, & Tapangco in 1996; Mayer & Gallini in 1990; Moreno & Mayer in 1999 and 2002; Halpern D., Graesser A., & Hackel M., 2007; Pashler, H., Bain, P., Bottage, B., Graesser, A., Koedinger, K., McDaniel, M., & Metcalfe, J., 2007; Clark, R., & Lyons, C. 2011. All the above research and many more have present evidence of support to the usage of multimedia principle in education, and investigated its boundary conditions.

Clark & Mayer articulated “Multimedia presentations can encourage learners to engage in active learning by mentally representing the material in words and in pictures and by mentally making connections between the pictorial and verbal representations. In contrast, presenting words alone may encourage learners especially those with less experience or expertise—to engage in shallow learning such as not connecting the words with other knowledge”(Clark R. & Mayer E., 2011, p71) . In the following sections will discuss the usage of multimedia principle in education, and its boundary conditions.

Reasons for Multimedia

Multimedia supports the way the human brain learns efficiently. In 2005, Mayer defined the cognitive theory of multimedia learning (CTML); the theory illustrated how to build multimedia instructional using cognitive science strategies to combine words and graphs in ways that maximize learning effectiveness.

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Cognitive theory of learning (CTML) occurs when the Learners build mental representations from words and graphic. The CTML theory analysis how to help human brain learns efficiently taking into consideration a number of field including psychology, neuroscience, artificial intelligence, computer science, linguistics, philosophy, and biology. This science explores and analyzes the human mental processes such as perceiving, thinking, remembering, understanding, and learning (Stillings, Weisler, Chase, Feinstein, Garfield, & Rissland, 1995).

The cognitive theory of multimedia learning (CTML) highlight the notion that human brain attempt to create significant relations between words and pictures and that they learn efficiently than they could have with words or graphs alone (Mayer, 2009). According to CTML, one of the principles of cognitive theory of multimedia learning is to support the human brain to create a reasonable mental representation from the learning material. The human brain's task is to perceive the new material as an active participant, and eventually build new knowledge.

Boundary Conditions

Many research has recommend using multimedia-words and graphics, rather than words alone in teaching. This section investigates the relationships between words and graphics. How words and graphics work together to create meaning for the learner?

Teaching environments does not only present information that the learner needs to know, but it also enables the learner to make sense out of the material. Harp & Mayer found that words and graphics irrelevant to the lesson goal can deprive learning, (Harp & Mayer, 1997). Therefore, graphics that decorate the page should be minimize in any learning environments, and integrate graphics that support the learner grasp of the material.

Clark and Meyer articulate "Providing relevant graphics with text is a proven method of fostering deeper cognitive processing in learners. In short, learning is facilitated when the graphics and text work together to communicate the instructional message" (Clark, R. & Mayer, R. E., 2008 p74).

Not all graphics create meaning for the learner; some learning environments contain graphics that do not support the text. Research confirms that words and graphics must be designed together. Clark & Mayer explained "Pictures should not be an afterthought. Instead of selecting pictures after the words are written, instructional designers should consider how words and pictures work together to create meaning for the learner"(Clark R. & Mayer E., 2011, p71).

Sensitive to the level of prior knowledge

Educator should be sensitive to the level of prior knowledge of their learners. Many Researches have shown that multimedia instructional can supports and help low-knowledge learners but may not help high-knowledge learners. Mayer & Gallini in 1990 expressed that multimedia instructional were significant for learners who have little knowledge of the topic (novices) more than learners who have high knowledge of the topic (experts), Mayer and Gallini (1990). Another research by Ollerenshaw, Aidman, and Kidd (1997) confirmed that little knowledge learners (novices) benefited significantly when animation was added to instruction, whereas high-knowledge learners did not. (Clark & Mayer, 2011).

Accordingly educator should provide multimedia instruction to low-knowledge learners; more advanced group of learners or experienced in the topic, they may be able to learn well mainly from text or even mainly from graphics.

Static Content vs. Animation

Do learners learn material better when we include static graphics or animations graphics in instruction? Many educators have the impressions that static graphics are passive medium and are a not as good of a choice as animations which are an active medium. On the contrary, a number of research studies have uncover that animations graphics are not more effective than a series of static graphics illustrating the same material.

A research done by Mayer, Hegarty, Mayer, & Campbell, in (2005) demonstrated that static graphics in instruction can be more effective than animations graphics instruction. In their research they used two multimedia methods to describe lessons on how lightning storms develop. On one group they used a paper-based lesson of a series of static graphics with written text. On the other group they used a computer-based animations instruction where they used verbal. Learners in the paper-based lesson of a series of static graphics group achieved 32% better than students in the computer-based animations group.

The same results were found in several other studies, including lessons on lightning, ocean waves, hydraulic brakes, and toilet tanks. The static based lesson group always achieved better than the animation based lesson group. The static based lesson helped the learners to create mentally active processing, because learners had to mentally animate the changes from one graph to the next and were able to manipulate the order and rate of their processing. On the other hand, the animations instruction may possibly promote passive learning since the learner could not control presentation processing. To the contrary, some evidence demonstrated that animations instruction may be more effective for instruction that involve teach hands-on procedures. For instance, a research done in 1998 and 2009 proved that animations instruction was more helpful than static instruction to teach learners how to make folding paper flowers and hats, (ChanLin, 1998; Wong, Marcus, Ayres, Smith, Cooper, Paas, & Sweller, 2009). The same results were found in several other studies, including instruction to teach learners to tie knots and puzzle rings (Ayres, Marcus, Chan, & Qian, 2009).

In general, static instructions are suitable to promote understanding of processes, whereas animated instructions are suitable to teach complex manual skills.

Graphics

Many researchers have demonstrated that adding relevant graphics to instruction can support learning. But what types of graphics that are mainly effective for different instructional goals. How can the Lerner plan and design graphic instructions that are likely to improve learning outcomes? This research uncovered three main factors that shape the effectiveness of your visual treatments: The communication functions of graphics; instructional goal, and the Stages of learning. The following sections discuss each of these factors.

Communication Functions of Graphics

Graphical communication incorporates visual material to convey knowledge, such as pictures, drawings, photographs, movies or any means that utilize a graphics to help in conveying knowledge, instruction, or an idea. Clark & Lyons in 2011 described seven communication functions of graphics:

1. *Decorative graphics:* Decorative graphics are frequent types of graphics that are used in instruction materials. It is used to inspire instructional display by adding artistic appeal or humor, but has no real instructional target. It is argued that overuse of Decorative graphics it can hinder the learning process. Decorative graphics should be used moderately in the instructional materials.
2. *Representational graphics:* are also frequent types of graphics that are used in instruction materials to represents an object in a realistic fashion. Representational graphics are used to illustrate or represent the appearance of content. It can be presented in various way including photographs, screen captures, and line drawings.
3. *Mnemonic graphics:* it provides a reminder of factual information. Example is a graphic of bronchi “Inhale a bite, goes down the right”
4. *Organizational graphics:* commonly used in training materials to demonstrate qualitative relationships among content. For example they are used to familiarize learners of the organization and order of lesson content.
5. *Relational graphics:* It presents quantitative relationships among variables. A common examples include line graph or A pie chart

6. *Transformational graphics:* demonstrate variation of objects over time and space. Transformational graphics frequently used in combination with representational graphics to demonstrate procedures and processes. A common examples include an animation or a video
7. *Interpretive graphics:* It describes a theory, concepts, principle, or cause-and-effect relationships. Schematic diagram or animation. Clark, R., & Lyons, C. (2011)

Different types of Graphics for each Instructional Goal

Different types of instructional goals require different types of graphics. Clark & Mayer in 2008 described five types of instructions and the graphic types commonly used to teach each specific type.

1. *Facts:* Unique and isolated information such as specific application screens, forms, or product data. Graphic types commonly used to teach this type of instruction are representational, and organizational.
2. *Concepts:* Groups of objects, events or symbols designated by a single name. Graphic types commonly used to teach this type of instruction are: Representational, Organizational, and Interpretive.
3. *Process:* is a step-by-step description of how a system works, including business, scientific, and mechanical systems. Graphic types commonly used to teach this type of instruction are Transformational, Interpretive, and Relational
4. *Procedure:* A series of steps resulting in completion of a task. Graphic type commonly used to teach this type of instruction is Transformational.
5. *Principle:* Guidelines that result in completion of a task; cause-and-effect relationships. Graphic types commonly used to teach this type of instruction are: Transformational, and Interpretive.

(Clark, R. & Mayer, R. E., 2008)

Stages of learning

Clark & Lyons in their book *Graphics for learning* identified the five stages of learning. According Clark & Lyons (2004), each stage requires different type of multimedia lessons that containing both words and graphics as summarized in the following table.

Psychological Functions of Graphics		
Instructional Event	Definition	Example
Support Attention	Graphics and graphic design that draw attention to important elements in an instructional display and that minimize divided attention	•An arrow to point out the relevant part of a computer screen •Placement of graphic close to text that describes it
Activate or Build Prior Knowledge	Graphics that engage existing mental models or provide high-level content overview to support acquisition of new information	•Visual analogy between new content and familiar knowledge •Graphic overview of new content
Minimize Cognitive Load	Graphics and graphic design that minimize extraneous mental work imposed on working memory during learning	•Line art versus photograph •Relevant graphic versus decorative graphic
Build Mental Models	Graphics that help learners construct new memories in long-term memory that support deeper understanding of content	•A schematic diagram to illustrate how equipment works •A visual simulation of how genes are transmitted from parents to offspring
Support Transfer of Learning	Graphics that incorporate key features of the work environment; graphics that promote deeper understanding	•Use of software screen simulation that looks and acts like actual software •Use of a visual simulation to build a cause-and-effect mental model
Support Motivation	Graphics that make material interesting and at the same time do not depress learning	•A graphic that makes the relevance of the skills to the job obvious •An organizing visual that clarifies

		the structure of the material
Clark, R., & Lyons, C. (2004). Graphics for learning. New York: Wiley & Sons		

Conclusion

Multimedia instructional design combines words and graphics to enhance learning effectiveness. Using Multimedia instruction can help learners engage in active learning. But again not all graphics are equally effective; we need to maintain balance, not to overuse graphics but integrate them to maintain the learning aim that we intend to take place.

This concludes Choosing the best multimedia instructional for learning objectives depends on your instructional goals, stages of learning, and the learners' knowledge level who will participate. The communication functions of graphics category each serves a different purpose and is best aligned with specific instructional goal, stages of learning, and , and the learners knowledge level.

References:

[1] Ayres, P., Marcus, N., Chan, C., & Qian, N. (2009). Learning hand manipulative tasks: When instructional animations are superior to equivalent static representation. Computers in Human Behavior, 25, 348–353.

[2] Butcher, K.R. (2006). Learning from text with diagrams: Promoting mental model development and inference generation. Journal of Educational Psychology, 98, 182–197.

[3] ChanLin, L. (1998). Animation to teach students of different knowledge levels. Journal of Instructional Psychology, 25, 166–175.

[4] Clark, R., & Lyons, C. (2004). Graphics for learning. New York: Wiley & Sons.

[5] Clark, R.C., & Mayer, R.E. (2008). Learning by viewing versus learning by doing: Evidence-based guidelines for principled learning environments. Performance Improvement, 47, 5–13.

[6] Clark, R.C., & Lyons, C. (2011). Graphics for learning (2nd ed.) San Francisco: Pfeiffer.

[7] Clark, R. & Mayer, R. (2011). E-Learning and the Science of Instruction (3rd ed.) San Francisco: Pfeiffer.

[8] Fletcher, J.D., & Tobias, S. (2005). The multimedia principle. In R.E. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp. 117–134). New York: Cambridge University Press.

[9] Halpern, D.F., Graesser, A., & Hakel, M. (2007). 25 Learning principles to guide pedagogy and the design of learning environments. Washington, DC: Association of Psychological Science Taskforce on Lifelong Learning at Work and at Home.

[10] Harp, S.F., & Mayer, R.E. (1997). The role of interest in learning from scientifi c text and illustrations: On the distinction between emotional interest and cognitive interest. Journal of Educational Psychology, 89, 92–102.

[11] Mayer, R.E. (1989). Systematic thinking fostered by illustrations in scientific text. Journal of Educational Psychology, 81, 240–246.

[12] Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R.E. Mayer (Ed.), The Cambridge Handbook of Multimedia Learning. New York: Cambridge University Press.

[13] Mayer, R.E. (2009). Multimedia learning (2nd ed.). New York: Cambridge University Press.

[14] Mayer, R.E., & Anderson, R.B. (1991). Animations need narrations: An experimental test of a dual-processing systems in working memory. Journal of Educational Psychology, 90, 312–320.

[15] Mayer, R.E., & Anderson, R.B. (1992). The instructive animation: Helping students build connections between words and pictures in multimedia learning. Journal of Educational Psychology, 84, 444–452.

[16] Mayer, R.E., Bove, W., Bryman, A., Mars, R., & Tapangco, L. (1996). When less is more: Meaningful learning from visual and verbal summaries of science textbook lessons. Journal of Educational Psychology, 88, 64–73.

[17] Mayer, R.E., & Anderson, R.B. (1991). Animations need narrations: An experimental test of a dual-processing system in working memory. Journal of Educational Psychology, 90, 312–320.

[18] Mayer, R.E., & Gallini, J.K. (1990). When is an illustration worth ten thousand words? Journal of Educational Psychology, 88, 64–73.

[19] Mayer, R.E., Hegarty, M., Mayer, S., & Campbell, J. (2005). When static media promote active learning: Annotated illustrations versus narrated animations in multimedia instruction. Journal of Experimental Psychology: Applied, 11, 256–265.

[20] Moreno, R., & Mayer, R.E. (1999a). Cognitive principles of multimedia learning: The role of modality and contiguity. Journal of Educational Psychology, 91, 358–368.

[21] Moreno, R., & Mayer, R.E. (2000a). A coherence effect in multimedia learning: The case for minimizing irrelevant sounds in the design of multimedia instructional messages. Journal of Educational Psychology, 92, 117–125.

[22] Ollerenshaw, A., Aidman, E., & Kidd, G. (1997). Is an illustration always worth ten thousand words? Effects of prior knowledge, learning style, and multimedia illustrations on text comprehension. International Journal of Instructional Media, 24, 227–238.

[23] Pashler, H., Bain, P., Bottage, B., Graesser, A., Koedinger, K., McDaniel, M., & Metcalfe, J. (2007). Organizing instruction and study to improve student learning. Washington, DC: National Center for Educational Research, Institute of Education Sciences.

[24] Robinson, D.H. (2002). Spatial text adjuncts and learning. Educational Psychology Review, 14(1).

[25] Stillings, N. A., Weisler, S. E., Chase, C. H., Feinstein, M. H., Garfield, J. L., & Rissland, E. L. (1995).Cognitive science: An introduction (2nd ed.). Cambridge, MA: MIT Press.

[26] Wong, A., Marcus, N., Ayres, P., Smith, L., Cooper, G.A., Paas, F.G.W.C., & Sweller, J. (2009). Instructional animations can be superior to statics when learning human motor skills. Computers in Human Behavior, 25, 339–347.

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