A Review of Learning Theories from Visual Literacy

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Elaine Huei-Lien Chen is a doctoral student in Curriculum and Instruction with an emphasis on educational computing, design and online learning. She decided to continue her education so that she can better inspire her students to learn, just as her teachers fostered her love of learning. Her favorite quote is "learning without thought is labor lost, thought without learning is perilous." Elaine is interested in cognitive learning theories that promote higher order thinking. Visual thinking is one of them to make learning straightforward. Her recent paper was a starting point to fulfill learning with thinking. Elaine can be reached at echen@ksu.edu.

Abstract

This short paper is based on "Creating Graphics for Learning and Performance - Lessons in Visual Literacy" written by Dr. Linda L. Lohr (2003). In her book, Lohr not only presents research studies and theories of learning from visuals, but also provides lessons and examples in creating effective visual instructions. This paper focuses on three theories related to mind and memory that are frequently addressed in the field of visual literacy: information processing theory, dual-coding theory, and multimedia theory. In addition to fostering a better understanding of these theories, three principles of perceptions along with illustrations are also provided.

Introduction

Many people that work with educational technology have the false impression that visual elements are comprised only of graphical images. In fact, visual elements not only include text but also color, simple shapes, depth, space, and typography. These elements are "tools" that are frequently used in instructional design. Designers deal with tools as well as visual features such as contrast, alignment, repetition, and proximity to create effective images that directly influence perception. Although it is not always true that "a picture is worth a thousand words," significant research has found that learning is improved by well-communicated images. In particular, Lohr (2003) has identified three theories (figure/ground principle, hierarchy principle, and gestalt principle) that help most of us in understanding learning with visuals.

Information Processing Theory

Information processing theory is also known as the "dual-store model of memory." In 1968, Atkinson and Shiffrin proposed a model of memory based on two types of memory, short-term memory and long-term memory. Short-term memory includes sensory memory and working memory. Sensory memory contains unlimited capacity while working memory contains very limited capacity. Nevertheless, the major problem for both types of memory is the restricted duration to hold information.

In1956 Miller's study showed evidence that working memory holds approximately seven units of information for approximately ten to twenty seconds. To overcome this limitation, the author indicated that people tend to "chunk" information. For example, it takes eleven digits to dial an international call from Taiwan to the United States. In terms of human memory a better way to present 00517853956194 is 005-1785-395-6194 because chunked information is easier for most people to view and remember. If something has been remembered, it means we have successfully moved information from short-term memory to long-term memory. Although long-term memory contains almost unlimited capacity and is believed to be more permanent, passing information into long-term memory is a big challenge.

Atkinson-Shiffrin's model emphasized using knowledge acquisition strategies: *selection* to quickly grasp most important information and ignoring unrelated information; *rehearsal* or *repetition* to keep information long enough in working memory; and *coding* to make new information meaningful to the learner by associating new information with something the learner already knows. Thus, information can be shifted from short-term memory into long-term memory.

Dual-Coding Theory

According to Paivio (1990), images and words have different cognitive representations, therefore, the brain uses separate memory systems for different types of information: verbal memory and image memory. Verbal memory is related to language systems, while image memory includes graphics, sounds, tastes, and nonverbal thoughts. Pavio indicated that when verbal information is acquired from sensory memory, it moves to verbal processors. Likewise, when visual information is acquired, it moves from sensory memory to visual processors. The crucial point occurs when information in either processor can activate the information in the other processor. It is confusing, but think about when you see the word *Shrek*. People who have seen the movie of the same name may promptly reference an image of green ogre. In this example, the individual remembers both

the text and the image because it is meaningful. In contrast, for people who do not know *Shrek*, that word is less likely to trigger the image processor. As a result, it is hard to remember.

Pavio's dual-coding theory is also appropriate when referring to the retrieval of information from memory systems. Paivio claims that memory is set up as a network with different paths, verbal and image, that lead to the same information. The more pathways learners use to remember information, the more cures learners can recall that information later on.

Multimedia Theory

Richard Mayer is an expert in multimedia learning. His multimedia theory is drawn on Paivio's Dual Code Theory (1990), Sweller's Cognitive Load Theory (1994), and Bruner's Constructivist Theory. Mayer and his associate Mareno (2000) conducted a study in deriving instructional design principles from cognitive theory in multimedia learning. They suggest that active learning occurs when a learner engages in three cognitive processes: selection, organization, and integration.

- *Selection*: The learner selects relevant words for verbal processing and select relevant images for visual processing. Based on Miller's finding stated earlier, people are able to process chunked information. During that time, learners must select relevant words and/or images to be stored in verbal and/or visual memory systems to overcome the limitations of memory.

- *Organization*: The learner organizes words into coherent verbal models and organizes images into the coherent visual models. The more we think about and organize information in meaningful ways, the more we repeat information in our working memory, and the more likely we are to remember it. Notice that our minds organize new information in different ways. Some information may be arranged sequentially, hierarchically, or randomly according to the nature of information, some may be organized based primarily on an individual's knowledge and previous experience.

- *Integration*: Mayer's research has shown that learners learn better when corresponding verbal and visual information are held together because it makes learning more meaningful. Ideally, verbal and visual information are linked and assist each other; therefore, when receiving verbal information and images simultaneously, the learner processes different modes of information all at once.

How can these theories help designers create effective visuals for instruction? Lohr (2003) proposes three principles of perception that parallel Mayer's principles of selection: organization, and integration of the cognitive processes.

Three Principles of Perceptions

Figure/Ground Perceptions

Some individuals find it difficult to multitask because their minds have the tendency to pay attention to only one thing at a time. For example, when we concentrate on keyboarding using a computer, we may see almost nothing but the computer monitor. We ignore the keyboard itself. The monitor is the "figure," and the keyboard becomes irrelevant "ground." However, when we look at the keyboard to correct spelling, the keyboard becomes the "figure," and the monitor turns into the "ground." The definition now is clear: the focus of our attention is the figure, and whatever the mind is not focusing on is the ground. Instructional designers need to make the most important information stand out and to reduce the amount of information that memory needs to process. The use of big font, contrasting color, space, and shape are strategies that direct attention to what is important.

Here is an example of using figure/ground principle: notice that they are several menu options on the navigation bar, but the orange colored background makes the *Activity* section stands out; likewise, the sub menu *Online Journal* is in the orange brackets which directs the users where they are. Apparently, the rest of the options on the menu serve as ground images but would be easily to access at anytime (Figure 1).

Figure 1. Retrieved from http://www.coe.ksu.edu/ecdt/ Used with permission from Abdullah Walidi.

Hierarchy Perceptions

Hierarchy refers to a type of organization. It is the pathway that leads learners from one unit of information to the next unit of relevant information. When direction is provided, learners have clear structures to follow and they avoid disorientation. Presently reading from the top to the

bottom and from the left to the right are standard directions for visual navigation on the web. Details including, arrows, bold lines, diagrams, and motions are tools that can be used to manipulate the hierarchy of visual perception. The example here shows the use of hierarchy: from the path, there is no confusion about what pages user is navigating through. On the other hand, user can easily track back if needed (Figure 2).
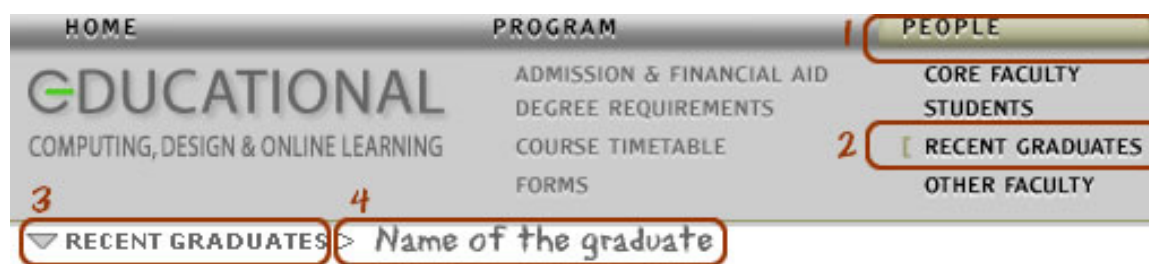

Figure 2. Retrieved from http://www.coe.ksu.edu/ecdt/ Used with permission from Abdullah Walidi.

Gestalt Perceptions

Gestalt is a German word that means *whole* or *form*, but as a design concept the meaning of this term is not so simple. A commonly held definition of gestalt is *the whole is greater than the sum of its parts*. When instructional designers optimize gestalt in instruction, they are helping learners to see the big picture. Specifically, Edward Tufte (1990) stated that good design is grounded in simple message, but holds rich content in detail. Simplicity is a challenge for designers to structure an underlying message and provide learners with access to supportive information all together. The example in Figure 3 demonstrates a use of gestalt. Noted that all the components which including the title, main menus, sub menus, and content as one big image. At the same time, the individual parts provide access to rich information to support the underlying message that this site carries out.

Gestalt can be reached by any components that enhance the whole; it is an abstract concept for many of us. Accordingly, Lohr (2003) suggests five laws of gestalt in regard to design.

- *The law of closure*
  If we see a car behind a tree, our minds fill the gaps and envision a complete image of car somewhere in our brains. Because of this law, designers need not provide all related information. This will help to keep design simple and to reduce cognitive overload.

Figure 3. *Retrieved from http://www.coe.ksu.edu/ecdt/ Used with permission from Abdullah Walidi.*

- *The law of contiguity*

  We tend to follow a path or a flow because our minds seek logical sequence. Designers need to direct learners' attentions to follow the expected sequence. This law is similar to hierarchy principle.

- *The law of similarity*

  Our minds tend to group information into related categories. For example, a designer can use same color to represent a group of items. The repetition of the same color simplifies the information and allows the user to see the pattern.

- *The law of proximity*

  This law is also related to the concept of grouping similar information together. Placing items close to each other helps the user to group them into the same category. Employing the law of proximity in visual design can reduce the time required to select and process information.

- *The law of previous experience*

  People tend to construct knowledge based on prior knowledge or previous experience. From this constructivist point of view, designers need to facilitate learners to link new

information to previous experience. For example, metaphor is often employed to create linkage between new and existing information. Presenting a familiar symbol can reduce the amount of information that a user's mind needs to process.

Conclusion

For many years the misunderstanding and neglect of concepts that foster effective visual learning has impeded progress in the design of effective educational environments and materials. Numerous scholars have discussed the concepts of visual learning in education since Arnheim published "Visual Thinking" in 1969. Unfortunately a lack of academic research and training has resulted in a generation of educators that are unable to articulate and apply effective principles of visual design in education. Recently studies on visual processing explored basic concepts such as determining what part of the brain can process images most effectively have captured my attentions. This paper attempts to provide an overview of theories in learning from visuals and encourages educators to consider theories of perception when designing instructional materials. The three principles of perception complement each other and can be used in conjunction or separately. For anyone who is interested in instructional design, reviewing basic principles of visual design is essential.

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