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# Overloading on Slides: Cognitive Load Theory and Microsoft's Slide Program PowerPoint

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The integration of Microsoft's PowerPoint and other slideware programs into the classroom setting may hinder educational progress rather than help it. An examination of the literature focusing on Cognitive Load Theory recognizes that students' have a limited tolerance for the amount of sights and sounds on display at any given time, especially in learning environments. This article finds that an interdisciplinary approach is needed to effectively design slides that can educate without overloading the students.

Cognitive Load Theory (CLT) concerns the limited capacity of the brain to absorb new information (van Merriënboer & Ayres, 2005). Over the past few years, the theory has received more attention from researchers as new multimedia teaching tools become available (van Merriënboer & Ayres). This analysis hopes to further the research by analyzing the popular presentation tool PowerPoint by Microsoft.

## LITERATURE REVIEW OF MULTIMEDIA STUDIES AND INFORMATION PROCESSING

Many studies have been done to determine what effects multimedia presentations have on the processing of information (Mayer, 2002). However, many researchers found mixed results. Mayer first quantified the Cognitive

Theory of Multimedia Learning, which states, "meaningful learning occurs when learning engages in appropriate verbal and visuospatial thinking" (Mayer, 2002, p. 61). Three theory-based assumptions of cognitive learning should be considered when designing meaningful multimedia presentations. These theories are (a) Dual Channel Assumption, (b) Limited Channel Assumption, and (c) Active Processing Assumption (Mayer, 2002).

***Dual channel assumption.*** This theory takes into account that the working memory is divided into two parts: visual and auditory (van Merriënboer & Ayres, 2005). Due to the separate workings of the memory, the human cognitive system has two channels for processing and incorporating information: a visual-pictorial channel and an auditory-verbal channel (Mayer). The mind therefore conducts dual coding when multiple sources of information (text and picture) are included in a presentation. Simultaneous intake of multiple sources of information creates a higher chance of overloading the brain's visual processor. This is known as a modality effect. To correct the overload, the presenter should change the written text into voiced narration (van Merriënboer & Ayres, 2005; Hede, 2003).

***Limited channel assumption.*** The theory states that individuals have a limited capacity within each channel for storing, organizing, and retrieving knowledge (Mayer, 2002). When the working capacity is exceeded, cognitive overload may occur (Hede, 2003). In multimedia presentations, this overload is common when the student is receiving the same information in two or more formats, such as narration and text (Hede).

***Active processing assumption.*** This theory takes into account how the mind actively processes incoming information. Meaningful learning occurs when humans actively process and organize audio and visual information (Mayer, 2002). Cognitive linking occurs when the verbal and audio channels make long-term referential connections (Hede, 2003).

## SCHEMA CONSTRUCTION AND MEANINGFUL LEARNING

Van Merriënboer and Ayres (2005) stated that schema construction is the appropriate response to the limited capacity and the active processing assumptions. The brain has two types of memory: working and long term (van Merriënboer & Ayres). The working memory has a limited capacity for accepting new information because it does not have an appropriate method

for storing the new data. When new information is introduced to the working memory, a schema is created so the new data can be processed quickly and placed in hierarchical fashion for storage in the long-term memory (van Merriënboer & Ayres).

Three factors may inhibit information from being processed in the working memory:

1. The intrinsic nature of the task, known as intrinsic load.
2. The order and method in which the tasks are presented, known as extraneous cognitive load.
3. The amount of cognitive work the learner is willing and able to use for the task, known as germaine cognitive load.

The purpose of this research will focus on extraneous cognitive load because multimedia presentations specifically relate to this inhibiting factor (van Merriënboer & Ayres, 2005).

Dr. Richard E. Mayer of the University of California at Santa Barbara has conducted much research on the effects of multimedia learning on students' retention of a topic. By understanding how cognitive learning plays a part in real life settings, educators can merge new multimedia presentations with effective learning techniques (Mayer, 2002).

Multimedia instructional messages promote learning in the form of presentations, which can either be spoken or written, or in the form of visual presentations, which use animation, video, illustrations, and photographs (Mayer, 2002). Varied combinations of such verbal and visual materials were used by Mayer to create science presentations to test which factors yielded the strongest amount of student retention of the information (Mayer, 2002). He conducted several studies to determine what combination of text, audio, and pictures was the most effective and to what extent. Based on the study's findings, Mayer originated the following principles for meaningful learning:

***Multimedia principle.*** Students learn more effectively from multimedia presentations than from exclusively verbal information. They also learn more from presentations that use words and relevant pictures than words alone.

***Contiguity principle.*** Students learn more effectively when narration and pictures are presented simultaneously, rather than consecutively. This engages the mind to coordinate the audio and visual information instantly

in the brain's two channels, successfully creating a connection between the two items of information presented.

***Coherence principle.*** Students learn more effectively when the multimedia presentation is interesting and expanded than they do when the presentation is basic, that is, without extra, entertaining details. However, expanded presentations have a limit. Students do not learn efficiently when there are excessive or irrelevant sounds, motion, or video.

***Modality principle.*** Students learn more effectively when the presentation uses animation and narration together rather than animation and on-screen text. The visual channel can be overloaded when presented with several modes of visual information. This is also confirmed by Hede (2003). The Redundancy Principle (Mayer, 2002) is based on this same evidence and states that it is ineffective to combine animation, narration, and on-screen text into a single presentation.

***Personalization principle.*** Students learn more effectively when the words presented are conversational rather than expository.

***Interactivity principle.*** Students learn more effectively when they can control the rate of multimedia explanations.

***Signaling principle.*** Students learn more effectively when multimedia presentations are signaled. Signaling guides cognitive understanding by directing the learner to important passages or events in the presentation.

During his research, Mayer (2002) also found the most effective modes for using multimedia to ensure meaningful learning by students. The purpose of this research is to determine whether Microsoft's PowerPoint, the widespread multimedia presentation tool, is advantageous or a hindrance to the following above-mentioned guidelines. The default design techniques of PowerPoint will also be examined to determine if they help or hinder visual and audio processing as well as schema construction.

## POWERPOINT IN THE CLASSROOM

A limited amount of research has found a positive effect of PowerPoint on student learning and subject recall. Before the widespread use of computers and PowerPoint, teachers would present visual information either

on a blackboard or with transparencies (Bartsch & Cobern, 2003). Now a majority of classrooms come equipped with computers, or they have use of multimedia carts in order to use PowerPoint presentations while teaching. However, the comparative effectiveness of PowerPoint and transparency presentations is unclear (Bartsch & Cobern).

Bartsch and Cobern (2003) found that expanded PowerPoint presentations (text, photo, and audio) actually decreased the amount of student recall on a topic. However, students surveyed said they thought they learned more from the PowerPoint presentations than from transparency presentations (Bartsch & Cobern).

With regard to how well students learn to present PowerPoint presentations after graduation, Vik (2004) found major problems with the PowerPoint presentations of both graduate students and military personnel. Typically, slides were too long, contained distracting transitions, and led to an unclear organization of the information.

Bartsch and Cobern (2003) analyzed the amount of time needed to prepare a PowerPoint presentation. They found that the time to create a PowerPoint presentation was comparable to that needed to create transparencies. Because a professor's time is valuable, the amount of time needed to create PowerPoint pages should be comparable to that required to create transparency pages. Therefore, the researcher will also look specifically at the time-saving features of PowerPoint such as AutoContent and Smart Diagram.

## POWERPOINT DESIGN AND LEARNING

In his booklet *The Cognitive Style of PowerPoint* visual design expert Edward Tufte condemned the use of PowerPoint, stating that the program itself was making people "stupid" (Tufte, 2003) However, it should be noted that fellow researchers have criticized the booklet for being scientifically unsound (Doumont, 2005). The following research will analyze Tufte's assertions, Mayer's cognitive load principles, and van Merriënboer and Ayres work on schema construction, in order to analyze the effectiveness of Microsoft's PowerPoint program.

"Slideware helps speakers to outline their talks, to retrieve and show diverse visual materials and to communicate slides in talks, printed reports, and Internet. And also to replace serious analysis with chartjunk, over-produced layouts, cheerleader logotypes, and branding, and corny clip art. That is PowerPoint Phluff" (Tufte, p. 4).

The bells and whistles of PowerPoint can cause a user to lose sight of

the correct organization of content and purpose of the presentation. A PowerPoint slide is a relatively small place in which to write—10 x 7.5 inches. Tufte (2003) stated that projected slides are lower in resolution than 35mm slides. Because of the small nature of the slide, and the default design layouts in the program, only 30-40% of the slide can be devoted to text. This limited space yields an average of 15 words per slide. Tufte stated that the average human has been conditioned to read 300-1,000 words per minute. Based on this speed, the average audience is finished reading the slide, even before the speaker begins his talk. Furthermore, switching slides when speaking causes distraction, which interrupts the flow of information.

Audience understanding is hindered not only by sparse word count, but also by lack of hierarchical arrangement of bullet points. Van Merriënboer and Ayres (2005) stated that schema construction may become automated when there is an automated understanding of content or task orientation. Schemata decrease the time needed to process new information by causing less stress on the working memory, thereby decreasing overload of audio and visual channels. Specifically, the use of bullets, automated charts, and the nonsequential nature of the slides can lead to cognitive overload.

The use of bullet points is a second design technique that inhibits schema creation (Tufte, 2003). The PowerPoint program contains over one hundred bullet options, and if the presenter is still unable to find the specific bullet he wants, he may create custom bullets. But despite the fancy options, bulleted lists fail to show relationships among the points. Traditionally, relationships have been grouped by "sequence," "priority," and "membership" (Tufte, p. 5). Yet, a bulleted list can show only one relationship at a time. Because the reasoning behind relationships in a bulleted list is ambiguous, the viewer may not be able to process and store its information. Animation of bullet points can also delay the processing of content. PowerPoint's animation and transition features interrupt the flow of information, thus making it harder for the reader to grasp connections between lines of text. Moreover, the rapid movement employed in these features may detract from the spoken information.

Charts can be a good way to show simple statistics. PowerPoint has several features that help the user create an eye-catching diagram for the audience. Charts are best used for small pieces of information. However, in a presentation containing a large quantity of statistical information, a printed handout is more helpful to the audience than the chart feature. In PowerPoint the default charts distort the information and do not present a clear relationship of the data.

AutoContent is a feature of the program that allows users to create a slide presentation quickly by inserting the title; type of presentation—whether sales, general, or corporate; and type of projection—so that colors can be chosen correctly. The user can even decide whether the intended presentation is to show something successful, in progress, or failing. Then, the slides are created with bullet points stating what type of information the user should place in each point. Although the task may seem simple, both Tufte and the researcher tested the feature, and both had disastrous results.

Mayer's (2002) Interactivity Principle stated that students learn better when they can control the rate at which they receive information. One way to allow students to control a PowerPoint presentation is by displaying multiple slides at once within eye span (Tufte, 2003). Thus, students can process each slide as they need and draw the appropriate content relationships. To avoid signal overload, it is best for the presenter to be silent as the students take time to process the data. Similarly, to avoid Limited Channel Assumption (Mayer, 2002; Hede, 2003) the presenter should not read directly from the slide itself. However, speaking while a picture is displayed is appropriate.

Based on the research by Vik (2004), Tufte (2003), and Doumont (2005), the worst habits by PowerPoint users are as follows:

- too many or too few words per slide,
- backgrounds that are inappropriate and distract from the content,
- too much animation, sound effects, or video,
- too many slides for presentation length,
- overcomplicated graphics or charts, and
- lack of presentation structure and content relationships.

Slides are supposed to send a message to an audience: "not the detailed information (the what) but what this information means to the audience in view of the presentation's purpose (the so what)" (Doumont, 2005, p. 68). An effective slide presentation should feature a consistent background design; one or two easy-to-read typefaces (Times New Roman, Verdana, Helvetica) at varying sizes; and no text animation or on-screen transitions. Colors should be added last to signify important information or to add simple design flair.

Storyboards are a practical way to organize the presentation because they force presenters to stay on their main point. It is also recommended that presenters use a "blueprint slide" so that the audience can follow the presentation without losing track (Vik, 2004, 226).

Although PowerPoint offers dozens of transitions, Vik (2004) recommended using consistent transitions throughout the presentation. Too much animation and flashy graphics can make the audience lose focus. Vik also recommended that presenters transition from one topic to the next before switching to the next slide, so as not to distract from the lecture content.

## CONCLUSIONS

Although all "slides are not evil," slides do require much design consideration to be effective presentation tools. Tufte (2003) stated that PowerPoint is a branding tool perfect for advertisers and marketers. Despite the large array of features in PowerPoint, not all may be necessary or even beneficial to the tasks at hand. Based on the finds of this study, it is clear that the slide design of PowerPoint focuses more on quick phrases and flashy effects, than on a clear method to encourage learning and retention of the topic. Although great care can be taken to avoid overloading the audience, it is unclear how many professionals are taking the time to design their own slides, rather than relying on a faster production through PowerPoint's automation. Future research should examine how many companies are not only using the product, but surveys should be conducted to see if training programs are in place to teach proper design techniques. In the education realm universities should establish guidelines for proper PowerPoint formatting, as well as rules limiting the number of PowerPoint presentations in a semester.

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