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The Cognitive Load of PowerPoint: Q&A with Richard E. Mayer
By Cliff Atkinson

Many people have opinions about PowerPoint, but few can speak on the topic with the authority of Richard E. Mayer, Ph.D., professor of psychology at the University of California, Santa Barbara. Named the most prolific researcher in the field of educational psychology, Rich is the author of 18 books and more than 250 articles and chapters. His 12 years of research in multimedia learning and problem solving have important implications for PowerPoint users.

Cliff Atkinson: *Rich, the past 16 years has seen the rapid and widespread adoption of PowerPoint in corporations and educational institutions — an estimated 400 million copies now sit on desktops around the world. What do you make of this "PowerPoint phenomenon"?*

Rich Mayer: The success of PowerPoint depends in part on the fundamental need of people to communicate with others within the same community of practice. It is worthwhile to distinguish between two possible goals in making a PowerPoint presentation — *information presentation*, in which the goal is to present information to the audience, and *cognitive guidance*, in which the goal is to guide the audience in their processing of the presented information. When your goal is information presentation, PowerPoint slides can be full of information that may be extremely hard to process by the audience. However, since your goal is simply information presentation, you are not concerned with whether or not the audience can process the presented information. When your goal is cognitive guidance, you want to make sure that the audience members build appropriate knowledge in their memories. Your job is to communicate in a way that will have the desired impact on the audience, so you need to design your slides so they are consistent with how people learn. In my opinion, many of the examples of misuses of PowerPoint occur when the slides are designed to present information rather than to guide cognitive processing. In short, like any communication medium—including books — PowerPoint can be misused as a device for presenting information without regard for how the audience will process the presented information.

CA: *In your research you define multimedia as "the presentation of material using both words and pictures." Do your research findings in multimedia apply to PowerPoint users as well?*

RM: Research on multimedia learning is highly relevant to the design of PowerPoint presentations. For example, in *Multimedia Learning* (Cambridge University Press, 2001), I describe some research-based principles for the design of multimedia instructional messages including the following: *multimedia principle*, in which people learn better from words and pictures than from words alone; *coherence principle*, in which people learn better when extraneous material is excluded rather than included; *contiguity principle*, in which people learn better when corresponding words and pictures are presented at the same time or next to each other on the screen; *modality principle*, in which people learn better from animation with spoken text than animation with printed text; *signaling principle*, in which people learn better when the material is organized with clear outlines and headings; and *personalization principle*, in which people learn better from conversational style than formal style. For example, in designing a PowerPoint slide it is important to not present an overwhelming amount of information (i.e., coherence principle) and it is useful to have simple graphics to supplement words (i.e., multimedia principle). Finally, it is important to note that good design principles for inexperienced learners might not be the same as for experienced learners.

CA: *If an organization were interested in the impact of PowerPoint on their organization and wanted to review any research that has been conducted specifically on PowerPoint in any dimension, where would you recommend they go?*

RM: Although there is not yet a rich literature containing high quality research on PowerPoint, there already is an extensive literature on how to design paper-based instructional messages. It is worthwhile to make a distinction between media and methods. Media refer to the delivery systems

for communication such as books, computer screens, or PowerPoint presentations. Methods refer to the instructional methods used to help people learn, such as the coherence principle or personalization principle summarized in my previous answer. Research on instructional design has shown that the presentation medium does not create learning, but the presentation method does affect learning. Thus, PowerPoint does not create learning but the method you use for presenting information on PowerPoint does affect learning. For this reason, instructional methods that work with paper or e-learning are likely to also work with PowerPoint.

CA: *PowerPoint seems like it would be a difficult research topic because of the endless variables in any single presentation context. How have you addressed similar research problems in research on multimedia?*

RM: It is worthwhile to distinguish between a *technology-centered approach* and a *learner-centered approach* to the use of educational technologies including PowerPoint. In a technology-centered approach, the focus is on the capabilities of cutting edge technology. Thus, we would be interested in the effects of each of the many features of PowerPoint. In a learner-centered approach, the focus is on the way that people learn and process information. Thus, we would be interested in finding ways to use the features of PowerPoint to support people's natural ways of learning, that is, as aids to human learning. In my opinion, the learner-centered approach is more productive. For this reason, I would guide my study of PowerPoint by looking at features that might prime useful cognitive processing in the audience.

CA: *The use of bullet points in PowerPoint presentations has been widely criticized. Based on your research, what effect does on-screen text have on learning?*

RM: Bullets don't kill learning, but improper use of bullets kills learning. In order to create effective PowerPoint presentations, it is important to understand how people learn. In particular, cognitive scientists have discovered three important features of the human information processing system that are particularly relevant for PowerPoint users: *dual-channels*, that is, people have separate information processing channels for visual material and verbal material; *limited capacity*, that is, people can pay attention to only a few pieces of information in each channel at a time; and *active processing*, that is, people understand the presented material when they pay attention to the relevant material, organize it into a coherent mental structure, and integrate it with their prior knowledge. The implications are that: 1) PowerPoint presentations should use both visual and verbal forms of presentation, 2) filling the slides with information will easily overload people's cognitive systems, and 3) the presentations should help learners to select, organize, and integrate presented information.

CA: *As a researcher, how would you assess Edward Tufte's analysis of PowerPoint, and how does his monograph "The Cognitive Style of PowerPoint" relate to the body of scientific research on multimedia and related topics?*

RM: Edward Tufte has done much to draw attention to the design of effective graphics. However, I am not sure what is meant by the assertion that "PowerPoint is rarely a good method." If this statement means that PowerPoint is often misused, I wholeheartedly agree. However, I do not think it makes sense to refer to PowerPoint as a method. Instead, based on the distinction I made in a previous answer, PowerPoint is a medium that can be used effectively — that is, with effective design methods — or ineffectively, that is with ineffective design methods. We would not necessarily say that books are rarely a good method, because books can be designed using effective or ineffective methods. In my opinion, the same principle applies to PowerPoint.

CA: *In* Multimedia Learning*, you wrote "...if you designed a technologically sophisticated, aesthetically-pleasing, information-rich presentation, you would have failed to take into account an important human criterion: Is the presentation designed to be compatible with the way that people learn from words and pictures?" Based on your research, what are the characteristics of a PowerPoint that is compatible with the way people learn from words and pictures?*

RM: In a previous answer, I described three cognitive characteristics of how people learn, which lead to three questions for the design of effective PowerPoint presentations:

First, does the presentation take advantage of the dual-channel structure of the human information processing system, by presenting complementary material in words and pictures? In presenting a graph, for example, it is useful to have labels on the slide pointing out the main points.

Second, does the presentation take into consideration the limited capacity of the information processing channels, by minimizing the chances of overloading the cognitive system? In a recent

paper, "Nine Ways to Reduce Cognitive Load in Multimedia Learning" (published in the *Educational Psychologist*), I suggest techniques such as eliminating extraneous material. Thus, a bar graph should not be presented with three-dimensional bars and lots of cute, but irrelevant, clip art.

Third, does the presentation promote active cognitive processing by guiding the processes of selecting, organizing, and integrating information? For example, arrows can help highlight the main things that the audience should attend to, an outline can help people organize the material, and concrete examples — perhaps as video clips — can help people relate abstract concepts to their concrete experience.

All responses by Rich Mayer are © 2004 Richard E. Mayer

Cliff Atkinson is an independent management consultant specializing in organizational issues related to PowerPoint. You can visit his website at www.sociablemedia.com, read more articles here, or contact him at cliff.atkinson@sociablemedia.com.

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