An Analysis of the Coherence Principle of Multimedia Design

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The Coherence Principle is one of several multimedia design principles articulated by psychology professor Richard Mayer and his colleagues. The Coherence Principle states that people learn better from a multimedia presentation if extraneous words, pictures, and sounds are excluded (Clark & Mayer, 2008, Chapter 7). Extraneous material is any content that does not support the learning goal. The principle is supported by evidence obtained through empirical research on the different ways that people learn from multimedia presentations. The principle is most applicable to “low-ability” learners who have difficulty processing information (Clark & Mayer, 2008, p. 145). Extraneous material can interfere with learning in three ways (from Harp & Mayer, 1998, as described in Clark & Mayer, 2008, p. 142):

- **Distraction** —Extraneous material diverts the learner’s attention from the relevant material to the irrelevant material;
- **Disruption** —Extraneous material prevents the learner from building links between the different parts of the relevant material; and
- **Seduction** —Extraneous material leads the learner to draw from inappropriate existing (prior) knowledge to make sense of the new material.

Extraneous material is most likely to hinder learning under three circumstances (Clark and Mayer, 2008, p. 136):

- If the learner is unfamiliar with the subject matter,
- If the material is presented at a rapid pace, or
- If the presentation is not under the learner's control.

The Coherence Principle suggests that line drawings may be more appropriate than photographs of complex subject material if the photographs contain extraneous details that would require more effort for the learner to process. Even illustrations should not be embellished with realistic details if the embellishments could distract the learner from the learning objective (Clark & Mayer, 2008, p. 145).

Clark and Mayer point out that the Coherence Principle is constrained by a lack of research in some areas (pp. 150–151):

- **Authentic learning environments**—Research studies pertaining to the Coherence Principle usually take place in a controlled research environment with finite lessons, but the principle has not been substantially tested in longer-term, authentic learning environments.
- **Use of signaling**—Research suggests that signaling can improve learning from multimedia presentations. Signaling is a technique that uses visual cues such as arrows, lines, and bold face headings to direct the learner’s attention to a particular portion of an otherwise cluttered display. Additional research is needed.
- **Learner characteristics**—Research must be done to determine what effect individual learner differences have on the applicability of the Coherence Principle.
- **Level of learner interest**—Research has demonstrated that learners will learn better if they are interested in the material presented, but a level of balance must be found that promotes learner interest without causing undue distraction.
Examples of the Coherence Principle

Few educators would disagree with the idea that distractive elements in a multimedia presentation could hinder learning. But consistently applying the Coherence Principle in practice is not always easy. Because of the ubiquitous use of PowerPoint for creating presentations, numerous examples exist of cluttered PowerPoint presentations that violate the Coherence Principle. Atkinson and Mayer (2004) refer to this “PowerPoint clutter” phenomenon as *PowerPoint overload*. To avoid PowerPoint overload, they suggest adhering to five research-based multimedia principles, including the Coherence Principle: The rigorous removal of every element that does not support the main idea of the presentation (p. 14). Example 1 below shows elements of one PowerPoint presentation that violate the Coherence Principle. Example 2 that follows demonstrates elements of a video tutorial that successfully adhere to the Coherence Principle.

Example 1: Pollination PowerPoint Presentation
(Source: [http://science.pppst.com/systems.html](http://science.pppst.com/systems.html))

Example 1 includes three images from a PowerPoint presentation on plant pollination. All slides in this presentation contain the same busy and distracting background, which has no real purpose other than decoration. All blocks of text and images are overlaid on this background image. The “back” and “next” buttons on each screen insert additional unnecessary and distracting images.

Several slides such as this one in the Pollination presentation contain multiple sentences of text. The information would be more conducive to learning if “chunked” into smaller bits of information (Mayer, 1999, p. 616) or replaced with narration (Clark & Mayer, 2008, p. 146).

Replacing the image in this slide with a simpler and clearer line drawing to depict the parts of a flower could reduce the learner’s cognitive load and promote greater learning (Clark & Mayer, 2008, p. 145).

The images of flower petals in this slide do not support the main point of the text on the slide since the images show only what a petal looks like to a human, not an insect. Therefore, the images serve only as a decorative distraction that could hinder the learner’s ability to make sense of the information (Clark & Mayer, 2008, p. 142).
Example 2: Snagit Tutorial Video
(Source: http://www.techsmith.com/learn/snagit/10/video/intro-new/)

Example 2 includes three images from a tutorial video about Snagit, a screen capture and image editing program produced by TechSmith. The Snagit tutorial video, while not a perfect example of the use of the Coherence Principle, does demonstrate the correct application of certain aspects of the principle. The Snagit video tutorial consists of narration and screen capture video, but almost no onscreen text other than the text in the screen images. This practice avoids extraneous onscreen text in accordance with both the Coherence Principle and the Modality Principle, which states that people learn better when verbal information is presented as narration rather than onscreen text (Mayer, 1999, p. 616; Morena & Mayer, 2000).

The two images above demonstrate the use of signaling and the temporal contiguity principle (Morena & Mayer, 2000). In the first image, the content that the audio refers to on the screen is isolated visually from the rest of the screen content. In the second image, an arrow is added to direct the viewer's attention to an image on the screen referred to in the accompanying audio. These techniques avoid the use of onscreen text that would be extraneous and add to the learner's cognitive load.

In this image, a moving cursor guides the viewer's attention to the menu item discussed in the audio (signaling), and the screen image enlarges to show a smaller portion of the full screen. These techniques eliminate some of the visual elements on the screen to reduce the learner's cognitive load (Morena & Mayer, 2000).
Relationship of the Coherence Principle to Other Multimedia Learning Principles

Many of the multimedia design principles articulated by Mayer and his colleagues also support the Coherence Principle, primarily by eliminating or discouraging extraneous onscreen text. These principles and the ways in which they support the Coherence Principle are shown in Table 1 below.

Table 1. Multimedia design principles that support the Coherence Principle (Mayer, 1999; Morena & Mayer, 2000; Clark & Mayer, 2008).

<table>
<thead>
<tr>
<th>Name of Principle</th>
<th>Statement of Principle</th>
<th>How it Supports the Coherence Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia Principle</td>
<td>People learn better from words and graphics than from words alone.</td>
<td>Avoids extraneous onscreen and narrated text by replacing text with images.</td>
</tr>
<tr>
<td>Contiguity Principle</td>
<td>People learn better if words are near or contiguous to their corresponding graphics.</td>
<td>Encourages conciseness by limiting the screen real estate available for text.</td>
</tr>
<tr>
<td>Modality Principle</td>
<td>People understand a multimedia explanation better when the words are presented as narration rather than onscreen text.</td>
<td>Avoids extraneous onscreen text by replacing it with narration.</td>
</tr>
<tr>
<td>Redundancy Principle</td>
<td>People learn better from animation and narration alone than from animation and narration plus onscreen text.</td>
<td>Avoids extraneous onscreen text by replacing it with narration and animation.</td>
</tr>
</tbody>
</table>

The Coherence Principle and Theories of Psychology

As with all of the multimedia design principles developed by Mayer and his colleagues, the Coherence Principle is based on research about the ways people learn. The cognitive theory of multimedia learning assumes that people have a limited capacity for holding information in their working memory; therefore, extraneous audio and decorative graphics can overload the learner's working memory capacity and hinder learning (Clark & Mayer, 2008, p. 142). Since people have two separate channels for processing graphics and for processing verbal/auditory information (Clark & Mayer, 2008, p. 36), even background music can create competition for the learner's ability to process narration and onscreen text.

One counter-argument to the Coherence Principle suggests that some extraneous content can be advantageous in a multimedia presentation if it arouses the learner's interest—a view known as the arousal theory. In response to this argument, Clark and Mayer (2008, pp. 137–138) point out that entertaining but irrelevant material merely distracts the learner instead of making the relevant material more interesting. The extraneous graphics can disrupt the learner's ability to make sense of the material and therefore hinder learning.
Discussion

The Coherence Principle makes intuitive sense. Anyone who has attempted to make sense of new information can appreciate a clean, simple, and organized design, so the "less is more" concept is a good one for instructional designers to aspire to when developing multimedia presentations. The main difficulty with the Coherence Principle is that it provides only a general guideline rather than a “one size fits all” rule. Learning is a dynamic and individualistic activity with many variables that can combine or cancel each other out to influence the learning outcome. Instructional materials that are ideal for one group of learners in one context may be entirely inappropriate for another group of learners in another context.

Clark and Mayer (2008) addressed some of the research shortcomings on the Coherence Principle, including differences among individual learner characteristics and prior knowledge, variations in different learning contexts, and aspects of the instructional subject material. Additional variables that might affect the outcome include the amount of extraneous material the learners are exposed to during a lesson or within a certain time frame, the point during a lesson that the extraneous material is presented, and whether the relevant instructional material is repeated after the learner is presented with irrelevant, extraneous material. Clark and Mayer (2008, p. 145) noted that learners presented with a simplified visual probably fill in the visual gaps to make meaning out of the visual, which supports the idea of using simple illustrations for instruction...unless the learner fills in the gaps with incorrect information. Nearly everyone has had the experience of misinterpreting the lyrics of a song, so misinterpretation is likely to happen with narrated instructional material as well. Thus, applying the Coherence Principle is a tricky undertaking that requires balancing the cognitive load exacted upon the learners with the complex set of variables within each learning context.

References