Technological Contexts for Cognitive Growth

What do you think?

"One of the most consistent findings when the educational technology research literature is carefully reviewed is that ***there are few if any improvements in learning outcomes specifically attributable to the technology alone***. That is, when technologies such as online presentation and discussion of teaching case studies by teacher education students are compared with traditional approaches (e.g., the same students reading and discussing teaching case studies in the classroom), there seldom are learning benefits attributable to the technology itself (e.g., see Clark, 1994, 2001, 2003; Salomon, 1984)."

Bruning, Schraw, & Norby (2011)

Cognitive Load Theory

- **Refers to the level of demands placed upon WM in a given learning environment--common to research in educational technology**
- **Load can be:**
  - **intrinsic (inherent properties of the to-be-learned information)**
  - **extraneous (how the to-be-learned information is presented)**
  - **germane (cognitive load that is relevant to learning and creation of schemas)**
- **The goal of instructional design is to not exceed WM limits and to maximize germane load**

Example of Types of Cognitive Load

- Learners with same prior knowledge (thus similar amounts of intrinsic load) are presented with a problem in 2 separate conditions – Condition A intended to increase germane load by providing a worked example; Condition B no worked example
- Average perceived mental effort rating for Condition A = 8 (out of 9) and Con B = 6
- Learners in Condition A perform higher on a posttest than those in Condition B
- We can assume the worked example presented germane cognitive load that led to learning outcomes

Some examples of desirable difficulties

(provided by Jeffrey Bye, 2011)

- Spacing learning sessions rather than massing (Baddeley & Longman, 1978; Dempster, 1990)
- Testing learners on material rather than simply restudy (Roediger & Karpicke, 2006)
- Having learners generate target material through an active process rather than passive reading (McDaniel et al., 1994)
- Varying the settings of learning
- Making material less clearly organized for learners with some background knowledge (McNamara et al., 1996)

Mayer & colleagues recommendations:

1. ***Contiguity***: presenting related information (e.g., verbal and visual information) simultaneously rather than successively

2. ***Coherence***: Clarity in the presentation of information; avoiding the processing of extra words, sounds, and pictures.

3. ***Modality***: Take advantage of WM's ability to process information through visual and verbal modes and avoid redundancy

Expertise Reversal Effect:

- Employing cognitive load reduction techniques is not always appropriate
- Learner expertise plays a role in the effectiveness of cognitive load reduction
- Generally, as factors are added to multimedia presentations to reduce cognitive load by adding instructional guidance, students with high levels of expertise on the topic can find this redundant
- Thus, these students are suffering from the *redundancy effect* and experiencing unnecessary extraneous load.

(Kalyuga, Ayres, Chandler, & Sweller, 2003)

Evidence for the Expertise Reversal Effect:

Kalyuga, Chandler, & Sweller (1998)

- Participants were electrical trade workers and had differing levels of expertise in the area of electrical engineering.
- The workers were presented with either diagram-only instruction, or diagram + integrated text.
- The workers with higher expertise in the area of electrical engineering benefitted more from the diagram-only presentation than those with the same level of expertise that received the diagram + integrated text presentation.
- However, the workers with lower expertise levels benefitted more from the diagram + integrated text presentation.
- The redundancy of the material placed extraneous cognitive load on the “experts”, but helped the “novices” further understand the material

Research Team

- Interdisciplinary Coordination
  - Computer Science
  - Educational Psychology
  - Curriculum & Instruction
  - K-12 students and teachers
- Infrastructure
  - Computational: Game Technology
  - Personnel: Graphic Design & Animation