Designing for Cognitive Load

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As an instructional designer, I believe that course design should be aligned with how people learn in order to improve the overall learning experience.

Sweller's Cognitive Load Theory (CLT) can assist with this and is based on studies of human cognitive architecture: how we process and organise information.

In our brains, we have two types of memory. The first is our working memory, which we use to process new information. The capacity of our working memory is quite limited so it can only handle so much before it becomes overloaded. The second is our long-term memory, which is where we store and retrieve information. Within our long-term memory, information is organised into schemas, which are like filing cabinets. Not exceeding working memory capacity will result in greater transfer of information into long-term memory.

Cognitive Load Theory proposes that there are three types of cognitive load:

Intrinsic: this is the level of complexity inherent in the material being studied. There isn't much that we can do about intrinsic cognitive load; some tasks are more complex than others so will have different levels of intrinsic cognitive load.

Extraneous: this is cognitive load imposed by non-relevant elements that require extra mental processing e.g. decorative pictures, animations etc. that add nothing to the learning experience.

Germane: these are elements that allow cognitive resources to be put towards learning, assisting with information processing.

The three types of cognitive load are additive. For instruction to be effective:
Intrinsic load + Extraneous load + Germane load < Working memory capacity

To assist in transfer of information from working memory to long-term memory, information needs to be presented in such a way that it reduces extraneous cognitive load and, if possible, increases germane cognitive load (or includes items that assist with information processing). Note: I've found that much of the available literature tends to focus on reducing extraneous cognitive load.

From the research into CLT, a number of effects have also been discovered that influence the ability to process information, which in turn can hamper learning:

Split-Attention Effect: This occurs when multiple sources of information must be integrated before they can be understood. For example, in a diagram with text, the text should be integrated or placed near to the relevant part of the diagram rather than having to move back and forth from one source of information to the other.

Modality Effect: Working memory has both a visual processor and an auditory processor. As a result, using both processors can effectively expand the size of working memory if the cognitive load is distributed across both processors. This can be achieved when some information is presented visually (e.g. words and images) and other information by using sound (e.g. narration).

Redundancy Effect: Redundant information is any information not relevant to the learning experience. This effect occurs when the same information is presented in different forms (e.g. narrating on-screen text or using text that repeats information contained in a diagram). It also includes using decorative pictures, background music or cartoon images that don't contribute to learning.

Expertise Reversal Effect: As expertise increases, previously essential information becomes redundant and should be removed. Including information that is needed for novice learners in courses for learners with more expertise would place higher levels of extraneous cognitive load on the experienced learners.

Mayer and Moreno (2003) conducted research into ways to reduce cognitive load in multimedia learning. Their research, built on CLT, was based on three assumptions:

1. Humans possess separate information processing channels for verbal and visual material *(Dual Channel)*.
2. There is only a limited amount of processing capacity available via the visual (eyes) and verbal (ears) channels *(Limited Capacity)*.
3. Learning requires substantial cognitive processing via the visual and verbal channels *(Active Processing)*.

They found that designers should do the following to assist learners in processing information:

- Present some information via the visual channel and some via the verbal channel.
- Break content into smaller segments and allow the learner to control the pace.
- Remove all non-essential content – this includes background music and decorative pictures that don't add value.
- Place words as close as possible to the corresponding graphics.
- Don't narrate on-screen text word for word.
- Synchronise visual and verbal content (i.e. don't place them on separate screens).

All of this research is extremely useful as it provides evidence-based insights into how people process information. In turn, it allows designers to create courses based around the processing limitations that people have. As a result, by incorporating these factors into our designs, we can improve the overall learning experience.

References:

Clark R.C, Nguyen F, and Sweller J, 2006, *Efficiency in Learning: Evidence-Based Guidelines to Manage Cognitive Load*, Wiley

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