

SUPPORTING STUDENT LEARNING ONLINE: COGNITIVE LOAD

What is Cognitive Load?

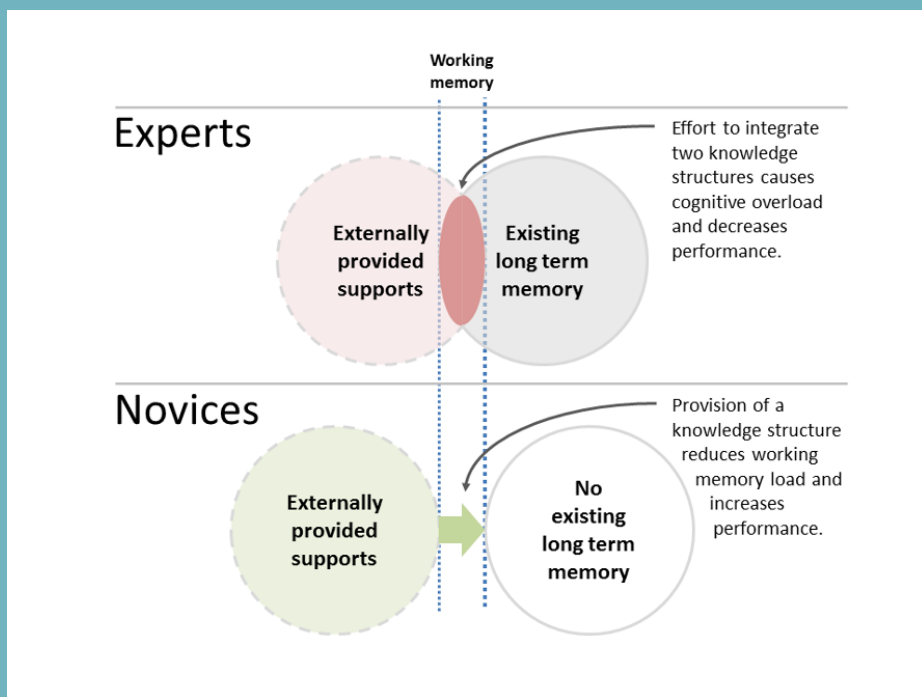
Cognitive load theory (Sweller et. al, 1998, 2019) explains the factors that facilitate or hinder learning, based on the ways that information is processed and stored by the learner. Before information is transferred to long-term memory, it is processed by our working memory, which is limited in the amount of information it can store. Cognitive load theory provides strategies for presenting information in ways that respect the limitations of working memory, and facilitate the transfer of information to long term memory.

Intrinsic cognitive load is the inherent difficulty of the material to be learned.

Extraneous cognitive load is determined by how the material is presented and the learner tasks involved. It can be manipulated by changing how instruction is delivered.

Germane cognitive load is the cognitive load required to learn. In other words, it refers to the amount of working memory devoted to the intrinsic cognitive load (the focus of learning), rather than the extraneous cognitive load. (Sweller et al., 2019, pp. 263-264).

The amount of cognitive load involved in a task also varies by learner expertise.



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Designing Learning Experiences to Manage Cognitive Load

Learners who have a low level of baseline knowledge in an area (ie. novices, students in lower-level courses) have not yet developed significant background knowledge or deep mental schemas related to the course learning content. Therefore, a greater amount of working memory typically is devoted to learning, and a more structured, step-by-step processes is needed to reduce cognitive load. Learners with more experience in an area can typically learn more intrinsically complex material without experiencing cognitive overload because of the existing knowledge stored in long-term memory.

To facilitate the most effective online learning environment, we aim to minimize extraneous cognitive load, while directing working memory resources towards the intrinsic cognitive load.

What does this mean in practice?

1. Consider the existing knowledge base of your students. If they are novices, more effort will be needed to reduce cognitive overload.
2. Implement practices that support learning by reducing cognitive overload.

Practices that support learning

- Reduce uncertainty by providing clear guidance, examples, and criteria that indicate what successful learning in your course looks like (Sweller et al, 2019, pp. 285-286)
- Break complex content into smaller segments (Clark & Mayer, 2011, p. 209). Aim for video segments of 6 minutes or less (Guo, Kim & Rubin, 2014)
- Provide guiding questions for videos and readings (Brame, 2015)
- Provide pre-training for complex concepts. For example, if a learning task requires the understanding of a significant amount of new vocabulary, present this before the main lesson or learning task (Mayer & Moreno, 2003, p. 47)
- Sequence materials based on the cognitive load that they create for a novice learner. For example, in a problem-based course, the learning sequence may (1) presentation of a full worked example, (2) a problem-completion task where students finish a partially complete problem, (3) independent practice on a full problem (Sweller et al., 2019). The intrinsic cognitive load of the tasks increases, but learners are prepared step by step to manage the task.
- Provide signalling cues (such as arrows, colours, or selective text) to indicate key information (Mayer & Moreno, 2003, p. 48).

Practices that can make learning challenging

- Presenting words in both audio and written form simultaneously. This can overload the audio/ visual channel. Choose which modality (audio or visual) is best for your situation rather than using both. Text is most useful for key words and information such as formulas (Clark & Mayer, 2011, pp. 117-130)
- Asking students to integrate from two sources of information to understand a single concept (Sweller et al., 2019, p. 268). For example, presenting a text and glossary as two separate documents is more challenging than defining key words in the central document.
- Producing overly long videos, or presenting content in the same format as in-person lectures; these videos are generally less engaging for students (Guo, Kim & Rubin, 2014)

References

- Brame, C. J. (2015). Effective educational videos. Centre for Teaching. <https://cft.vanderbilt.edu/guides-sub-pages/effective-educational-videos/>
- Clark, R. C., & Mayer, R. E. (2011). E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning. Center for Creative Leadership. <http://ebookcentral.proquest.com/lib/kwantlen-ebooks/detail.action?docID=697625>
- Flock, H. S. (2020). Designing a community of inquiry in online courses. International Review of Research in Open and Distance Learning, 21(1). <http://www.irrodl.org/index.php/irrodl/article/view/3985/5270>
- Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of MOOC videos. ACM Conference on Learning at Scale (L@S 2014). <http://groups.csail.mit.edu/uid/other-pubs/las2014-pguo-engagement.pdf>
- Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. Educational Psychologist, 38(1), 43–52. https://doi.org/10.1207/S15326985EP3801_6
- Steptoegether. (2014). The differing effect of externally provided instructional guidance on learners with varying levels of prior knowledge.
- Sweller, J., van Merriënboer, J. J. G., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. Educational Psychology Review, 31(2), 261–292. <https://doi.org/10.1007/s10648-019-09465-5>

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