An introduction to cognitive load theory

Dominique Russell

How do we apply our understanding of how people learn, think and solve problems to classroom instruction? This is the question that underpins cognitive load theory – an instructional theory based on cognitive architecture (that is, the cognitive functions that allow us to learn).

John Sweller is an Emeritus Professor of Educational Psychology at the University of New South Wales and has spent decades researching this theory. In this Q&A, he speaks with Dominique Russell all about the cognitive load theory, and why it's important for teachers to understand.

John Sweller

Dominique Russell: Can you tell me about your work so far in researching cognitive load theory?

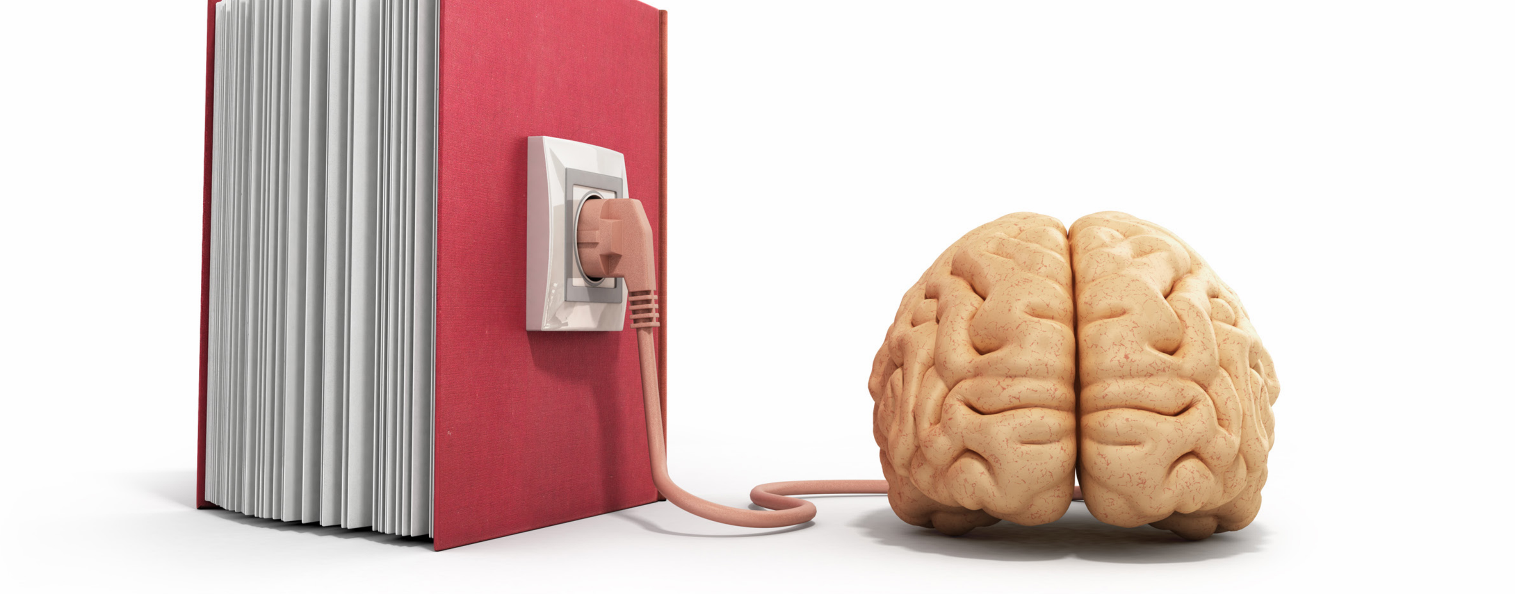
John Sweller: I began working in this area in the 1970s and 80s. At the time, I was running experiments on problem solving unrelated to the current theory. Some of the experimental results seemed strange. I gave people simple puzzle problems to solve. They solved them easily but seemed to learn almost nothing from the exercise. I needed an explanation for this result and that explanation gave birth to cognitive load theory. Here's what we now know was going on.

We have two major memory systems: working memory and long-term memory. We can think of working memory as consciousness. You are using working memory to read this text. When dealing with new information, working memory only can process two or three elements of information at a time and can hold those elements for only about 20 seconds. We can hold them for longer than 20 seconds if we rehearse them. If we want to retain information permanently, we must transfer it to long-term memory, which has no known capacity or duration limits.

My problem-solving students used their working memories to successfully solve their problems but had insufficient working memory resources to take the next step of learning what they had just done and transferring it permanently to long-term memory. Unless new information is transferred to long-term memory, nothing has been learned. To be of use to us, learned information, including complex concepts and procedures, must be stored in long-term memory.

We need to resist the temptation to assume that memory is simply there to store unrelated, rote-learned facts. Its main function is to store massive amounts of very complex, closely integrated knowledge. Without that enormous knowledge base stored in long-term memory, you would not be able to do what you are doing now!

I've spent the rest of my career expanding this cognitive architecture and applying it to solve educational problems. There now are hundreds of researchers from around the globe using the theory as a base for their work. The basic question underlying all cognitive load theory research is how do we apply our rapidly increasing knowledge of how people learn, think, and solve problems to instructional design? How should you design your lessons given how students' minds work?



DR: Why should cognitive load theory be of interest to K-12 teachers?

JS: As can be seen from its initial conception above, cognitive load theory is an instructional theory based on our knowledge of human cognitive architecture. In addition to the distinction between working memory and long-term memory discussed above, here are some additional aspects to human cognitive architecture that are relevant to teachers.

There are two categories of knowledge that teachers need to be aware of: biologically primary and biologically secondary. Primary knowledge is knowledge we evolved to acquire over many generations. Learning to listen to and speak a native language provides an example. We do not need to teach this skill because it is biologically primary and humans have evolved to acquire it unconsciously, and without tuition.

In contrast, we do need to teach children to read and write by using aids such as phonics instruction for written languages like English that are fully or partially phonetically based, because learning to read and write is biologically secondary. Unlike primary knowledge, secondary knowledge is acquired with conscious effort by students and explicit teaching by teachers. The characteristics of working memory and long-term memory described above apply to secondary, not primary knowledge.

The prescriptions of cognitive load theory are based on many thousands of randomised controlled trials run by hundreds of researchers from around the globe. It is that work that validates the theory and provides teachers with novel instructional procedures to consider.

DR: What does the implementation of cognitive load theory look like in the classroom?

JS: The cognitive architecture outlined above suggests that the way we learn in a classroom should be very different to the way we learn outside of a classroom. Outside of classrooms, most of what we learn is biologically primary and will be picked up without explicit tuition. It is a mistake to assume that what is taught in a classroom will be learned in a similar manner. It is learned very differently, with conscious effort by students and explicit teaching by teachers. It is unlikely to be picked up automatically without explicit instruction.

The data generated by cognitive load theory indicate that in order to reduce working memory load and facilitate transfer of domain-specific, biologically secondary information to long-term memory, instruction provided by teachers should be explicit and detailed. If we want to teach students how to write essays on the causes of the First World War, provide them with model answers to questions on the causes of the First World War. If we want them to learn how to solve mathematical problems, provide them with problems along with worked examples indicating possible solutions. In any area, providing students with worked examples to problems that they will face in the area will reduce working memory load and facilitate transfer of the needed information to long-term memory. Only after they have acquired a solid knowledge base is it appropriate to have them attempt to solve problems themselves.

DR: What's next for your research into cognitive load theory?

JS: Because of its large imprint these days, additional research using cognitive load theory is produced on a daily basis and it is impossible to keep track of all of it. With respect to my own research, currently I am working with collaborators on a very old effect, the spacing effect that was first discovered in the 1800s. If learning is spaced with rest periods between learning episodes, it is superior when compared with the same learning time massed without rest periods. There has never been a coherent, widely accepted agreement on why the effect occurs, resulting in it being largely ignored in education.

We are testing the hypothesis that working memory capacity depletes after heavy use and recovers after rest, which can potentially explain the spacing effect. With collaborators, I am testing this hypothesis in Australian, Indonesian and Chinese classrooms. The initial results are promising but it is early days.

DR: Do you have any recommendations for further reading if educators want to find out more on the cognitive load theory?

JS: For a more detailed discussion of the issues discussed in this article, along with many more, see *this article by Sweller, van Merriënboer, and Paas (2019)*.

In addition, the Centre for Education Statistics and Evaluation (CESE) of the NSW Department of Education has put out a brilliant series on classroom use of cognitive load theory:

- *Cognitive load theory: Research that teachers really need to understand*
- *CESE lunchtime talks: Cognitive load theory*

Dominique Russell is the editorial assistant of Teacher *magazine, an online publication for the education community published by the Australian Council for Educational Research. This is an edited version of an article that first appeared in* Teacher, *published by ACER. Reproduced with kind permission. Visit* teachermagazine.com.au *for more.*