THE CENTER *for* TRANSFORMATIVE TEACHING & LEARNING
AT ST. ANDREW'S EPISCOPAL SCHOOL

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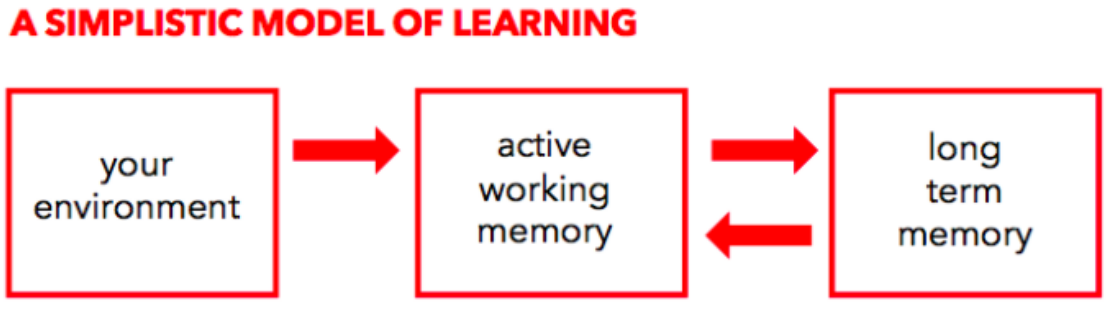
Welcome back to *The Bridge*, the monthly newsletter of the Center for Transformative Teaching and Learning. Each month *The Bridge* analyzes a specific aspect of teaching and learning through a Mind, Brain and Education Science research-informed lens.

# Why "Just Google it" is Not the Answer

**By Dr. Ian Kelleher**

How many times have you heard, "Kids nowadays can just Google what they need to know; they don't have to memorize stuff like we used to." Erm, no. That is not how our brains work.

The diagram below shows a simplistic model of how learning occurs. Sensory inputs from our environment - things we see, hear, read and so on - are processed alongside information retrieved from our long term memory. This happens in our active working memory. As a result of these ruminations in the active working memory, our long term memory is then altered. It is happening to you right now. You are retrieving prior knowledge from your long term memory and mixing it with what you are reading here in your active working memory. If you remember anything from reading this article, it is because some part of your long term memory has then been altered.




**Limitations to active working memory**

One critical feature of the active working memory is that it holds fewer items for less

time than we might assume. Seven items for thirty seconds is often quoted for adults, but these values will be smaller for children. Long-term memory, on the other hand, is virtually limitless. We can keep adding to it without end. The limit to our long term memory probably has more to do with our will power, opportunity, and time management than our brain's capacity.

Therefore, though we can only process a few pieces of novel information at once, a virtually limitless amount of information is stored in long term memory. Thus, the more abundant and more robust the schema of knowledge we have stored in our long term memory, the greater will be our ability to process higher levels of thinking in our active working memory. If we aim to rely on Google for the answer to everything, we quickly overwhelm our ability to process novel information in our active working memory. Plus, without that robust long term memory, will we even know what to search for? And how to assess the quality of the results of that search? For example, if you googled '*vaccines autism*,' you would get a flood of information that might sound convincing unless you had prior knowledge that this is horribly incorrect and dangerously fake nonsense.

**How do we learn?**

So how do we build our knowledge over time? We retrieve schemas of knowledge from our long term memory and work with them in active working memory, where we incorporate new information from our sensory inputs. We might modify these knowledge frameworks or create new ones based on them. We then store them back in long term memory until there is a need to retrieve them again. Can you think of a good metaphor for this?

The art of the master teacher is to, over time, help create robust schemas of knowledge in the long term memory systems of our students. Teachers strengthen long term retention of concepts by interleaving material, thus allowing for a degree of forgetting to occur before giving students a task that requires them to retrieve and rework ideas from their long term memory.

Another strategy to strengthen long term memory is to teach students some information and then have them use it. The master teacher carefully helps students construct a robust schema of knowledge, and then gives them challenging tasks that require them to use it in novel contexts. As students retrieve the knowledge and mix it with new information, they build more schemas, more complex schemas, and more robustly stored schemas of knowledge in their long term memory. Doing so requires teachers to know their subjects really well and their students really well as they meter out the knowledge and tasks in the right doses at the right time. This is part of the art and craft of teaching.

**An Introduction to Cognitive Load Theory**

Knowing stuff helps us know more stuff. This is not particularly revolutionary. But there is an additional level of detail. Our active working memory is not limitless. In fact, it is very limited. We say that there is a cognitive load capacity for our active working memory. There is only so much we can juggle in there at once - a feeling which, I am sure, we have all had. This is the basis of *Cognitive Load Theory*. Maybe the most important aspect of Cognitive Load Theory for teachers is that we need some spare

capacity in our working memory to effectively learn.

As we said above, we learn by forming new schemas in our long term memory. But in order to 'write' new schemas into our long term memory, we need some spare capacity in our active working memory. This spare cognitive capacity is called the ***germane load***. If we have sufficient germane load, we can form new long term memories; if we do not have enough germane load, we cannot.

But is there some spare *germane load* in our active working memory? Maybe, maybe not. It depends. There are two other demands on our active working memory's limited resources:

> ***intrinsic load:*** These are demands inherent in the mental task we are working on. These are what they are, and we have to be supremely cunning to do anything at all to lessen them.
> ***extraneous load:*** These are unnecessary demands that we may have added by how we have decided to set up and carry out the task in question. We often add extraneous load without noticing, and if we think about it, we can often find ways to reduce it.

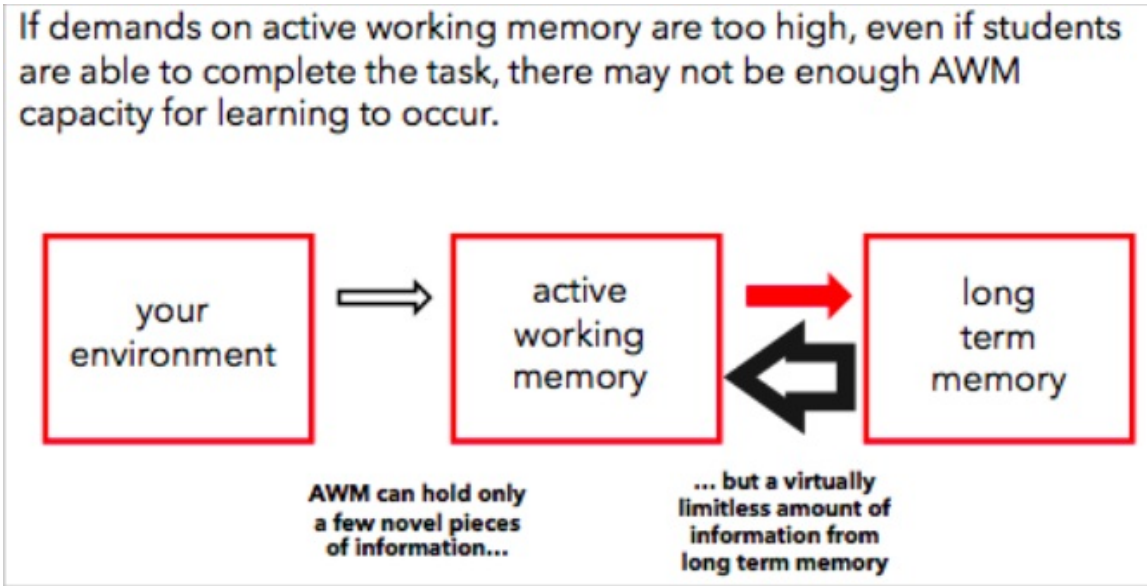
If the combination of **intrinsic load** and **extraneous load** is too great, there is not enough germane load capacity for our active working memory to develop and store new schema of knowledge in our long term memory.

**The need for *germane load* capacity in order to learn**
Read that last sentence again. Have you ever seen students able to complete a task, but unable to learn the underlying structure necessary to complete similar tasks independently? Pause to think of one or two specific examples of this.

Sometimes the cognitive load necessary to accomplish the work is so great it does not leave a student adequate cognitive load capacity to learn it. Does this ever happen in your classroom? Watch a master teacher in full flow, and I think you will notice that they are experts at figuring this out on the fly - setting the challenge bar high but leaving just enough mental space, or *germane load*, for robust learning to occur.

**What can we do to better manage cognitive load?**
But what can we all do to improve? We can eliminate unnecessary, extraneous cognitive load. A simple example would be to put away your phone with its Snapchat temptation, or not listen to music with words, while studying. But, as teachers, we can do more. What unnecessary cognitive load demands do we leave in place, in part, perhaps, because it's how we always learned?

Eliminating extraneous cognitive load where we can is important, because the alternative, tackling intrinsic load, is harder. In fact, until recently in the history of Cognitive Load Theory, people were unsure you could do anything to lessen intrinsic load. It is, after all, the cognitive demands inherent in the task itself, which are what they are. But there may be a way to do it.




The answer will resonate with teachers, I think. The intrinsic load may be lowered by building robust schemas in long term memory. Thus, when the new challenge is presented, there is some scaffolding already in place to help students begin mentally manipulating the task. Think about the careful way we structure our courses. There is an artistry in how we do it, an artistry which also speaks to the exquisite knowledge we have of our subjects. For example, what misconceptions or difficulties do students often encounter? And how can we scaffold around them? What skills and knowledge do I have to teach in October and December so they will be able to do this in February? It also requires us to know our students, and to attempt to put ourselves in their shoes as they encounter our subject for the first time. This is the patient building of knowledge and skills that master teachers carefully do with each of their students over time.

One example of this is using worked problems or worked examples. These tend to be really good for beginning or struggling learners. it helps them learn the pattern or schema in a situation with a lower overall cognitive load. Then, as students gain competency and confidence, remove these scaffoldings. Adding and then peeling away the right scaffolding at the right time is key to the art of being a master teacher.

Helping students construct knowledge, then, is a vital part of teaching. It is possible that we now know enough about cognition to be bold enough to say that helping students construct knowledge is and will always be a timeless skill. In the age of Google, and whatever out googles Google in time to come, we believe that there will always be a need for master teachers.

But this is only part of the story. How do we really make that knowledge stick? Think of all the ways in which we challenge students to use their newly acquired knowledge in a novel context - with the requirement that they need to express their thinking by creating an artifact in some medium. A paper, poster, object, video, podcast, game, museum-style exhibit, play, or what else can you think of? Carefully build core knowledge and skills, then demand students apply them. This is the way to build knowledge that is durable and agile. This is learning.

## Upcoming CTTL Events

**Diversity in the DMV: A Regional Student and Educator Conference**
February 23, 2018

**TAKOM: The Principles and Strategies of Neuroeducation**
June 18-20, 2018

**Creating Innovators Through Design Thinking**
June 18-20, 2018

**National Diversity Directors Institute**
June 24-27, 2018

**Science of Teaching and School Leadership Academy**
July 22-26, 2018

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