

Does it work for more able learners too?

2. Cognitive load theory (CLT)

Introduction

Schools are increasingly looking to the research evidence to understand how they can improve the learning and achievement of their students. Educational researchers such as John Hattie, Daniel Willingham, Barak Rosenshine and John Sweller have begun to influence the practice of many schools, while many are also undertaking their own school-based enquiries and research. Organisations such as the Chartered College, EEF and Ofsted are endorsing and disseminating evidence-based practices, with the result that it is not unusual to see in schools the use of Rosenshine's Principles to inform lesson planning, or cognitive load and recall theory informing curriculum planning and classroom pedagogy.

We know these practices are having a positive effect on many learners. However, it is important that we also interrogate these pervasive approaches – and their theoretical underpinnings – to evaluate what impact they have on different groups of learners, including the most able. In this series of information sheets, NACE sets out to do just that. This is part of our ongoing review of evidence-based approaches to teaching and learning, alongside a specific focus on research and developments directly affecting more able learners.

Following an information sheet on recall and retrieval practice, we continue the series with an overview of cognitive load theory (CLT) and related practices, and a consideration of their relevance to more able learners. Subsequent publications will consider areas including metacognition and pedagogical frameworks such as the Fisher-Frey model and Rosenshine's Principles of Instruction.

"I have come to the conclusion Sweller's Cognitive Load Theory is the single most important thing for teachers to know."

– Dylan Wiliam (Twitter, January 2017)

Many schools are taking a keen interest in cognitive load theory (CLT) and evidence from NACE member schools suggests this is having a strong influence on teaching and learning policies and classroom practice at both primary and secondary phases. In this review, we consider the main tenets of CLT and how it is being applied to teaching generally, and then look at the extent to which the theoretical framework can be applied to learners who show high ability and what that might look like in classroom planning and practice.

The context: what is CLT?

In a 2018 article published in Impact, journal of the Chartered College of Teaching, Dominic Shibli and Rachel West give a useful summary of the research relating to CLT and the reasons for it becoming the “Next Big Thing” in teaching. They explain that cognitive load refers to the cognitive effort (or amount of information processing) required to perform a task. If the cognitive load exceeds our processing capacity, we will struggle to complete the task successfully. It is therefore important for teachers to consider CLT when planning, leading, supporting and assessing learning.

As Shibli and West note, CLT requires an understanding of the role of working memory and long-term memory in learning – the former being “short term and finite” while the latter can be effectively treated as “infinite”. Moving knowledge into long-term memory reduces cognitive load, giving students a foundation on which to draw when facing new material. When this is not possible, working memory can become overloaded, leading to failures such as incomplete recall; failing to follow instructions; place-keeping errors and task abandonment (Gathercole and Alloway, 2007).

“Cognitive load theory asserts that learning is hampered when working memory capacity is exceeded in a learning task.”

– Ton De Jong (2010)

Shibli and West outline the three types of cognitive load identified by CLT:

- **Intrinsic cognitive load:** the inherent difficulty of the material itself, which can be influenced by prior knowledge of the topic;
- **Extraneous cognitive load:** the load generated by the way the material is presented and which does not aid learning;
- **Germane cognitive load:** the elements that aid information processing and contribute to the development of ‘schemas’.

As these descriptions suggest, there are steps teachers can take to reduce intrinsic and extrinsic cognitive load and support germane cognitive load, by considering what information is presented, when/in what order, and how.

“Cognitive Load Theory suggests that effective instructional material facilitates learning by directing cognitive resources towards activities that are relevant to learning.”

– Chandler and Sweller (1991)

Source: <https://impact.chartered.college/article/shibli-cognitive-load-theory-classroom-2/>

In practice: what's working?

CLT is supported by a robust evidence base which shows that students learn best when they are given explicit instruction with worked examples, accompanied by lots of practice and feedback. Through a significant number of randomised controlled trials, researchers in New Zealand have identified seven key strategies that can help teachers to maximise students' learning by optimising the load on their working memories:

1. Tailor lessons according to students' existing knowledge and skill

Drawing on information that is already stored in students' long-term memories can help reduce cognitive load – and thus result in more effective learning. By drawing on students' existing knowledge, and managing the amount of new information that students have to process at once, teachers can maximise student learning.

2. Use lots of worked examples to teach students new content or skills

Fully guided instruction using worked examples is more effective than unguided problem-solving when teaching students new material, because unguided problem-solving places a heavy burden on working memory.

3. Gradually increase independent problem-solving as students become more proficient

While fully guided instruction is very effective for teaching students new material, it becomes less effective as students become more expert at a particular skill. Eventually, fully guided instruction becomes redundant or even counter-productive and students benefit more from independent problem-solving.

4. Cut out inessential information

When students are provided with inessential information, they may not be able to distinguish between the information that they need to understand the lesson, and the inessential information that does not contribute to their learning. The inessential information adds to the load on their working memory, but does not contribute to their learning.

5. Present all the essential information together

Presenting information in a split format means that students have to hold two separate pieces of information in their heads at the same time, and mentally integrate them. This can overload the working memory and inhibit learning. Cognitive overload can be avoided by presenting separate sources of information together – in terms of both time and space.

6. Simplify complex information by presenting it orally and visually

Our working memories have two separate 'channels' – one for dealing with visual information, and another for dealing with auditory information. By spreading the delivery of information across both of these channels, teachers can manage cognitive load and make it easier for students to learn the information.

7. Encourage students to imagine concepts and procedures that they have learnt

Once students have a good grasp of the content, the mental process of visualising helps students to store the information more effectively in their long-term memories. This strategy should only be used once students are familiar with the content, as visualising imposes quite a heavy cognitive load.

Source: https://www.cese.nsw.gov.au/images/stories/PDF/Cognitive_load_theory_practice_guide_AA.pdf

What does this mean for more able learners?

As with any theoretical framework, it is important to examine relevance and impact for learners with disparate learning needs and capacity. In this instance, it is important to keep in mind that information which is essential for beginning students can become redundant as they become more advanced. Overlearning and overly frequent tests can also be counterproductive for more able learners.

Reif (2010) writes that if cognitive load is reduced too much, “the entire learning process would consist of too many small steps – and would thus become unduly fragmented and long”. Similarly, the New Zealand researchers note: “Providing too much guidance can cause more expert students to try to crosscheck the teacher’s guidance against what they already know. This cross-checking causes an unnecessary load on students’ working memories, but does not add anything to their understanding.” In addition, lack of cultural capital can add load to working memory and affect wider learning capacity.

Possible amendments needed for practical application to more able learners:

- Identify what cultural capital might be needed to access the new knowledge properly and teach this first; be aware of popular misconceptions. Be aware too that we might make assumptions about what more able learners already know and – for those who are new arrivals or for whom English is not their first language – what cultural gaps they have.
- Plan for more able learners to engage in problem solving when they have developed mastery of the content. To do this they will also need to have well-developed skills for independent learning as well as the ability to persevere and maintain focus and concentration.

Higher-end problem solving should only be introduced when the necessary content has first been mastered. Exam questions can often be scaffolded with various parts to a question leading on from one another. More able students can be given the final part to a question, leaving them to work through the problem without the given steps. This can only take place once they have mastered the necessary content to answer the question in the first place.

As students become very proficient, teachers should provide minimal guidance and allow students to practise their skills with lots of problem-solving tasks. It is important to note that even with a group of more able students, will progress to independent problem solving faster than others.

- Avoid giving additional information which may be redundant and might distract able learners from the lesson/task. This links back to Reif’s point regarding the need for more able learners to cross-check information. This is particularly pertinent as more able learners tend to have the capacity to be more critical of the information being delivered.

Example: maths

When teaching students products of prime factors, it is important for students to understand the mechanics of the problem first and practise questions to understand the topic fully. You can then discuss the application in real-life concepts such as cryptography to engage learners further, but only once the content has first been mastered. Many teachers introduce these ideas orally while students are still trying to master the content, causing cognitive overload for students.

- Encourage more proficient learners to visualise concepts. This strategy is similar to omitting steps from a worked example or gradually giving students fewer worked examples. It is often more effective than “fading out” guidance, because it avoids providing redundant information.

Example: maths

One of the strategies children are taught when “finding the difference between” or subtracting numbers is to count on from the lowest to the highest number in appropriate jumps. e.g. 120 minus 34: pupils are taught to jump from 34 to the next set of 10 (40) – a jump of 6, then from 40 to 100 – a jump of 60, finally from 100 to 120 – a jump of 20. The “jumps” are added together to calculate the answer: $6+60+20 = 86$. When this strategy is first introduced, a variety of concrete models are used to embed the learning. Once the concept has been grasped, pupils are asked to visualise the strategy in order to solve the calculation.

Example: literacy

More able readers are expected to use visualisation when predicting events or describing how a character might feel in specific circumstances. Pupils are able to draw on their existing knowledge, quickly applying this to new situations. Likewise, more able writers can be expected to draw on this knowledge to write from a particular point of view or in a specific context.

Example: physical education

In PE, a talented gymnast will be able to recall and demonstrate particular movements purely by visualising good examples that they have seen and understood previously.

Example: science

In science, when discussing states of matter, more able learners may be able to visualise animations or diagrammatic representations of the movement of molecules in order to explain the structure of solids, liquids and gases.

- Be judicious in your use of revisiting previous content and opportunities for testing/quizzing for more able learners. It is important that they have opportunities to practise retrieving information from their memories for longer-term recall and application (Willingham, 2010) but they may not need this practice as much as others and should prioritise time on learning and tasks which provide significant cognitive challenge and opportunities for independent learning.

Example: history

At primary level, with more able learners, we use entry tickets based on the key concepts learned previously, rather than an extensive quiz. This strengthens the long-term memory but allows more time for pupils to move on to learning tasks which involve deep thinking. For example, in history, we may ask a pupil to quickly recall Henry VIII’s wives and how they died, before asking them to explore the statement: “Henry VIII was a good king.” The information about the six wives is important in this exercise, but we don’t need to spend ages on recall about this. With more able learners, the retrieval practice is ongoing, with teachers asking those short, focused questions that check long-term memory as lessons progress, rather than having longer tests at the start or end of lessons.

References and further reading

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