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Cognitive Load Theory (CLT): *Practical classroom Ideas*

TEACH EAST London
Tower Hamlets

Steve Garnett has been a teacher for 29 years. He has delivered INSET to over 12000 teachers in the last ten years across the UK and Ireland as well as Europe, the Middle East, Africa, South America and the Far East too.

Steve believes that the most effective training takes place where it mirrors as closely as possible a 'real' classroom. So he will invite you to take part in the training with him. After all this is the best way to make it more enjoyable too. Perhaps Confucius summed it up better about 2,500 years ago when he said…

'I hear and I forget, I see and I remember, *I do and I understand'*

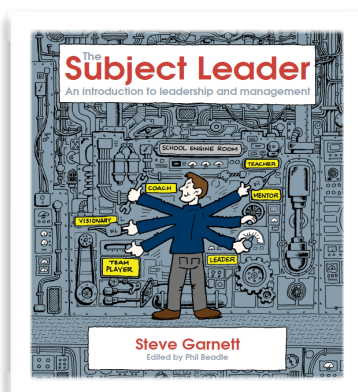Whilst Steve now lives in South Wales he remains a proud Yorkshireman.

(Email contact: stevegarnett1966@gmail.com)

Books written Steve Garnett include:
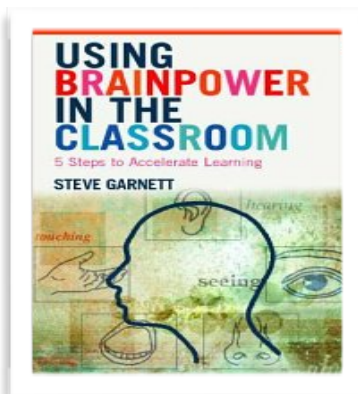
TES review

It very kindly described it as *'strong in its resume of the latest research into what constitutes effective learning'* as well as a *'handy synthesis of current thinking about learning'*

Phil Beadle (Guardian Education columnist) review

'*What's special about what Steve has written is that it connects back with the idea of the Subject Leader as being the guiding visionary of the department'* and that '*Its focus is sharp and steely on improving the learning experience for your students…'*

Shortlisted for Education Resources Award 2013 (Best Secondary Resource)

By the end of the training all colleagues should be able to:

- **1. Identify** some of the language associated with CLT

- **2. Summarise** some of the key ideas around CLT

- **3. Locate** the parts of the brain concerned with working memory and long term memory

- **4. Conduct** a test to show limits of the working memory

- **5. Explain** the benefits of Knowledge Organisers as a way of easing Cognitive Load on the working memory *(Link to CLT:Reducing 'intrinsic load')*

- **6. Explain** how dual coding is an efficient way of avoiding excessive cognitive load *(Link to CLT: using the 'modality effect')*

- **7. Explain** how retrieval practice can improve long term memory and as a result allow the working memory to handle far more information *(Link to CLT: Importance of retrieval practice and the 'testing effect')*

- **8. Identify** six core retrieval techniques that can support improvement in long term memory *(Link to CLT: 'testing effect')*

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Training Activity 1: Identify some of the language associated with CLT

working
intrinsic
extraneous
germane
schema
modality
overload
testing
retrieval

w	r	e	t	r	i	e	v	a	l	i
a	o	v	e	r	l	o	a	d	h	n
g	e	r	m	a	n	e	g	s	j	t
s	k	l	k	m	y	u	f	c	k	r
t	e	s	t	i	n	g	d	h	l	i
d	j	z	n	q	n	i	s	e	z	n
f	h	x	b	w	t	g	a	m	x	s
m	o	d	a	l	i	t	y	a	c	i
g	h	c	v	e	r	o	p	b	v	c
e	x	t	r	a	n	e	o	u	s	n

Training Activity 2: Summarise some of the key ideas around CLT

1. What is the name of the academic behind Cognitive Load Theory?

2. What is the name of the academic who said CLT is the most important bit of research every teacher should know?

3. What are the 2 key issues for teachers when thinking about Cognitive Load Theory?

4. What are the 3 types of cognitive load?

5. What is the most effective technique to get knowledge into the long term memory?

6. Create a definition for Cognitive Load Theory

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Training Activity 3: Locate the parts of the brain concerned with working memory and long term memory

Training Activity 4: Conduct a test to show the limits of the working memory

Training Activity 5: Explain the benefits of Knowledge Organisers as a way of easing Cognitive Load on the working memory *(Link to CLT:Reducing 'intrinsic load'*
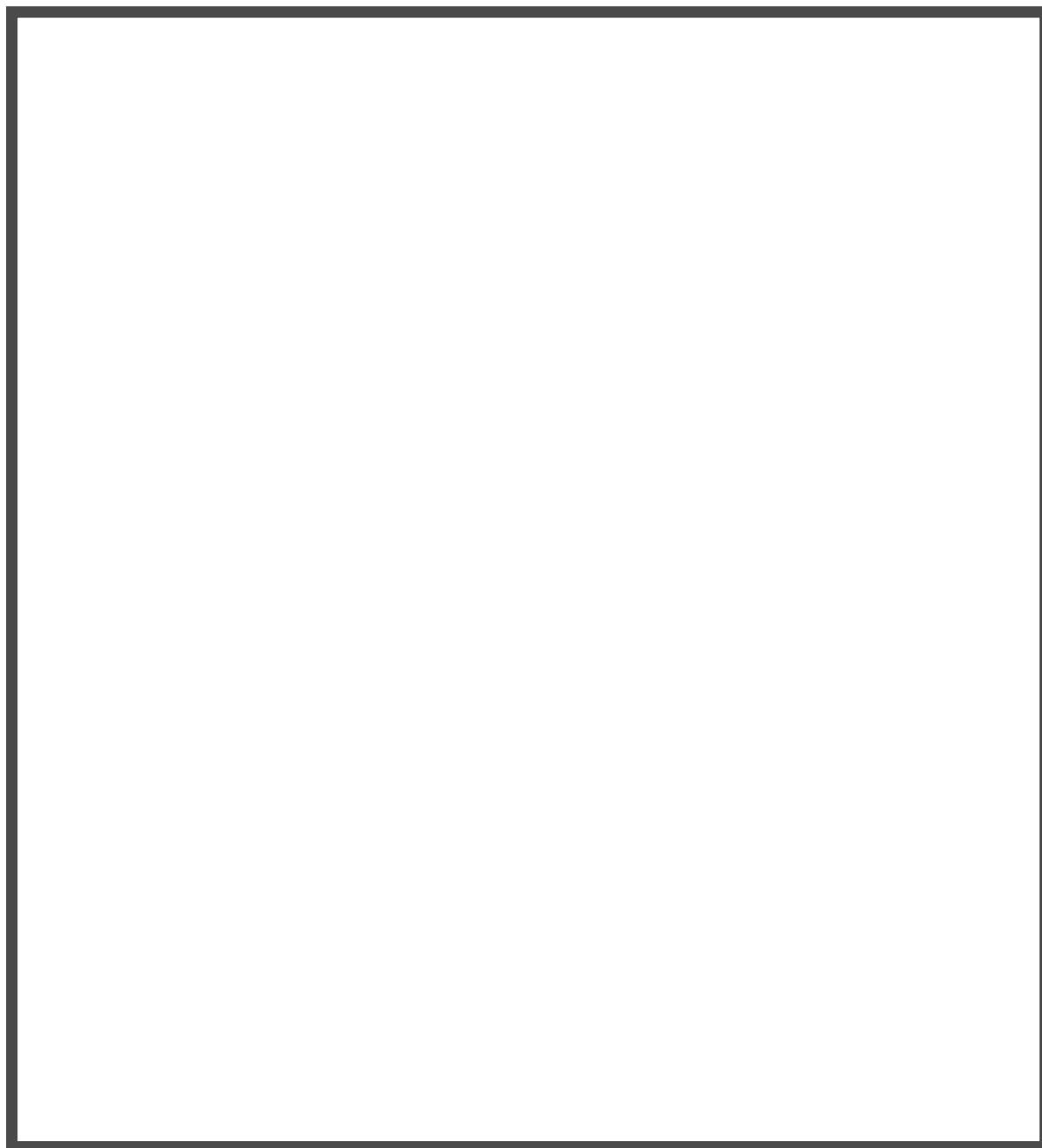
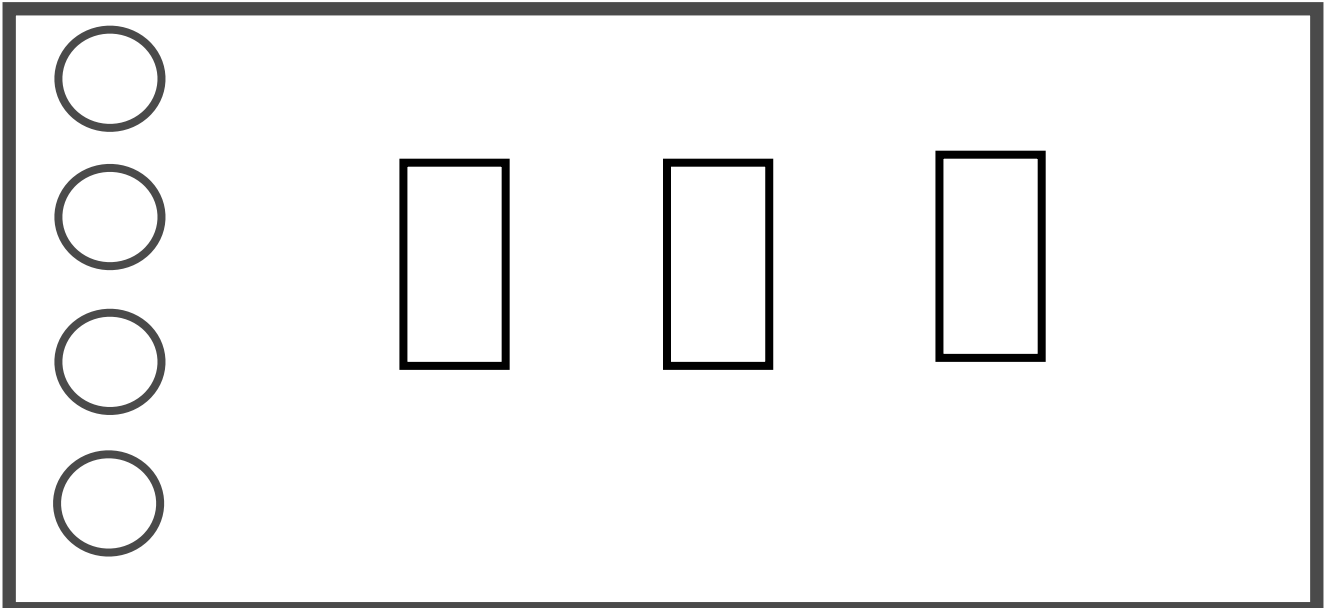The Three Rules for creating a 'CLT' friendly Knowledge Organiser?

1

2

3

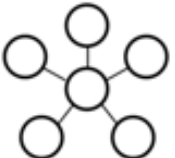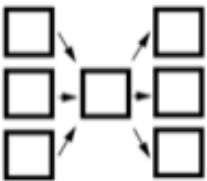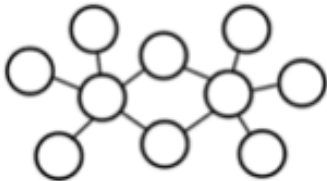## My version of an effective Knowledge Organiser for my subject
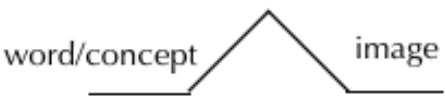
Training Activity 6: Explain how dual coding is an efficient way of avoiding excessive cognitive load *(Link to CLT: using the 'modality effect')*

1	2	3	4
5	6	7	8

Knowledge	Process
(recall/description)	(order/sequence/method/chronology)
Cause/effect	**Similarity/difference**
(Input/output)	(compare/contrast)
Classification	**Visualisation**
word/concept image	
(themes/groupings/sorting)	(analogy/metaphor/simile/showing same thing but in a different way)

Create a graphic organiser/diagram structure to show visually the correct type of 'thinking process'

Thinking process	Yours	Mine
A. Continuum: showing 'most' to least' at either end		
B. Cycle: No start or end - can have multiple stages within it		
C. Classifications and sub groups: showing both similarities and differences *(hint: kind of like a venn diagram)*		
D. Compare two topics against two criteria on a continuum		

Training Activity 7: Explain how retrieval practice can improve long term memory and as a result allow the working memory to handle far more information *(Link to CLT: Importance of retrieval practice and the 'testing effect'*
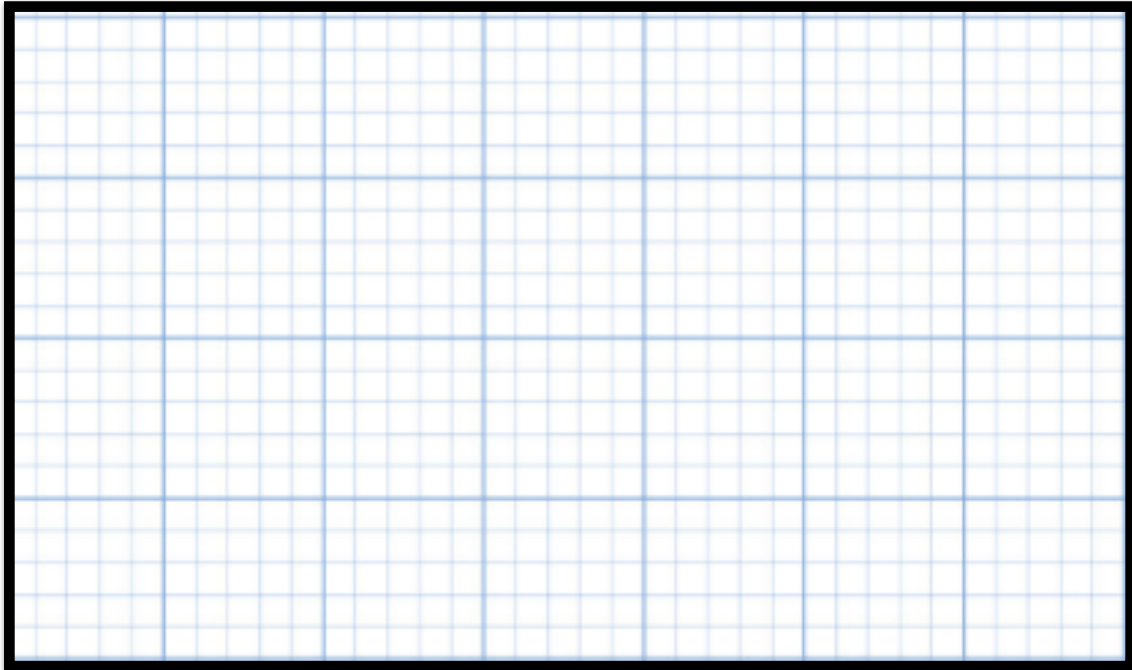
Training Activity 8 : Identify 6 core retrieval techniques that can support improvement in long term memory *(Link to CLT: 'testing effect')*
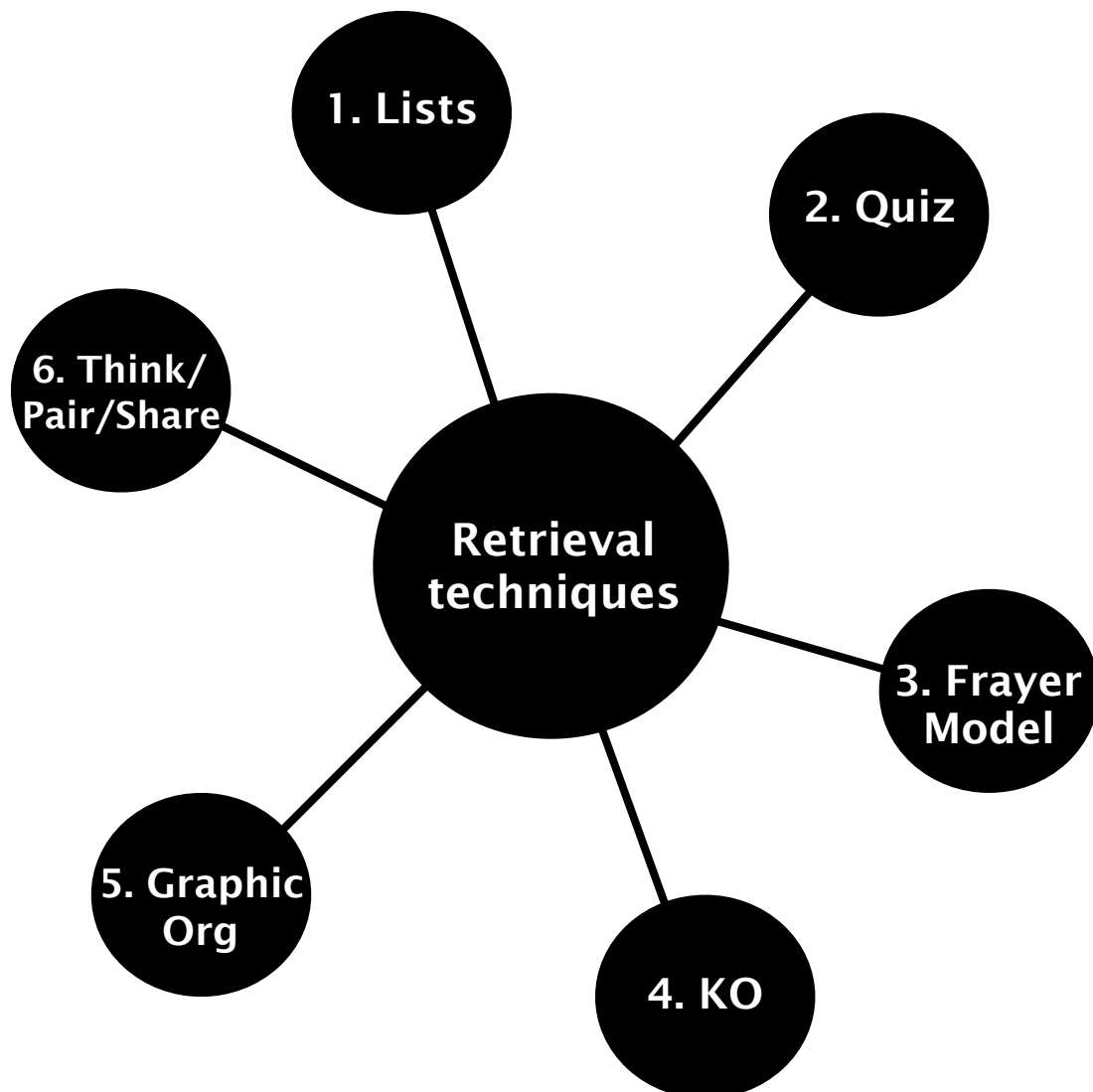
Some background on CLT

*'The implications of working memory limitations on instructional design can hardly be overestimated … Anything beyond the simplest cognitive activities appear to overwhelm working memory. Prima facie, any instructional design that flouts or merely ignores working memory limitations inevitably is deficient.'*
(Sweller, van Merrienboer & Paas 1998, pp. 252-253)

Cognitive Load Theory (CLT) has recently become 'The Next Big Thing' in teaching. Professor Dylan Wiliam (one of the world's most eminent educationalists and founder of Assessment for Learning) tweeted on 26 January 2017 that he had 'come to the conclusion Sweller's Cognitive Load Theory is the single most important thing for teachers to know.'
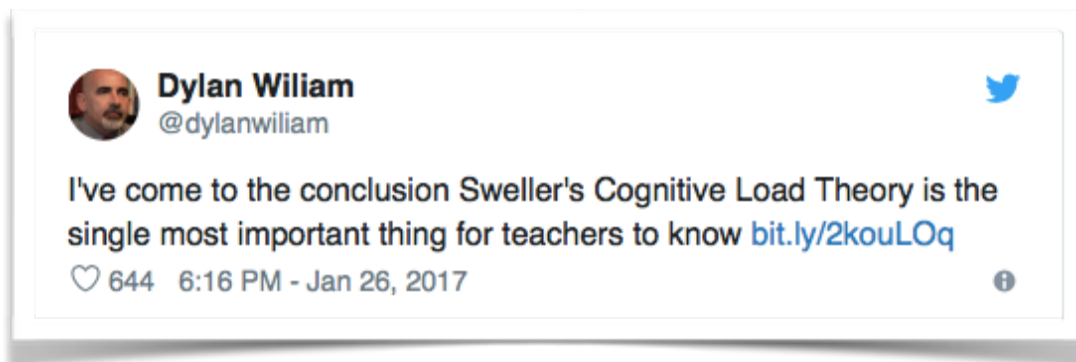
This is an emphatic statement and it is important to consider the implications. As teachers, there are huge demands on our time, so when considering a new strategy it is essential to evaluate the evidence.

CLT, first researched by Sweller towards the late 1980s, is based around the idea that our working memory – the part of our mind that processes what we are currently doing – can only deal with a limited amount of information at one time *when learning new or 'novel' information and the pupils are in effect the 'novice'.*

KEY ISSUE 1 : Try not to overwhelm the working memory when learning something new

The theory identifies three different forms of cognitive load:

· **INTRINSIC cognitive load**: the inherent difficulty of the material itself

Point 1: Pupils can be overwhelmed by too much content or receive too much content too quickly and this will thus exceed their INTRINSIC load

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· **EXTRANEOUS cognitive load:** the load generated *by the way* the material is presented and which does not aid learning

Point 2: Learning material to pupils can be unintentionally delivered and presented in a way that exceeds their EXTRANEOUS load because there is too much 'extra' but actually unhelpful material - 'less is more'

· **GERMANE cognitive load:** refers to the actual teaching itself of the content

Point 3: GERMANE load is exceeded when the teaching of more complex ideas/skills/processes is too wordy/abstract or detailed for a pupil to follow and so pupils are not able to show understanding themselves

——————————————————————————————-

CLT suggests that if the cognitive load exceeds our processing capacity, we will struggle to complete the activity successfully. In summarising CLT, De Jong (De Jong, 2010) states that *'cognitive load theory asserts that learning is hampered when working memory capacity is exceeded in a learning task'.*

Working memory should be seen as **short term** and **finite when learning novel information**, whereas long-term memory can be seen as **long term** and **infinite** The aim should be to move knowledge to long-term memory because when a student is exposed to new material, they can draw on this previous knowledge and the cognitive load is reduced.

Reducing cognitive load

1. **Intrinsic cognitive load** can be reduced by breaking down the subject content, sequencing the delivery so that sub-tasks are taught individually before being explained together as a whole. The idea is to not overwhelm a student too early on in the introduction of new work.

2. **Extraneous cognitive load** can be reduced by the way in which instructions are presented. We make sense of new material by referencing schema or mental models of pre-existing knowledge. Lack of clarity in instruction puts too high a load on the working memory, and so too much time is spent problem-solving the instructions as opposed to new schema formation. For example, lessons that use PowerPoint with excessive writing and the teacher talking at the same time, can inadvertently generate excessive cognitive load and lead to working memory failures. Chandler and Sweller (Chandler and Sweller, 1991) write that

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

Chandler and Sweller (Chandler and Sweller, 1992) found evidence of the split-attention effect. This occurs when different sources of information discussing the same topic are separated by time or space, such as a diagram with a key that corresponds to separate text next to it. When information is presented in this way, it is left to the learner to attempt to amalgamate it, which generates extraneous cognitive load. Therefore, it is recommended that if one of the sources adds nothing new, it should be eliminated. However, if it is essential to include both sources, they should ideally be physically integrated (e.g. texts and diagrams combined).

3. Germane cognitive load refers to the construction, processing and automation of schemas by the pupils. An example could be that the teacher needs to give pupils an explanation of the way to write an explained paragraph and all the necessary but separate elements involved. For many pupils too much explanation leads to a failure in remembering what to do - hence exceeding their germane load. Van Merriënboer et al., 2003) recommend using simple-to-complex sequencing to try to reduce germane cognitive load. They advise starting with worked-out examples (where a full solution is shown, which students then have to apply to a new question), then moving into completion assignments (where a partial solution is given and they have to complete it themselves), and then moving to conventional tasks, where they are simply given the question. This acts as a form of scaffolding, which helps students to learn independently, without necessarily needing the help of their teacher for each stage.

Renkl and Atkinson (Renkl and Atkinson, 2003) further investigated this fading form of scaffolding. They suggested that moving through activities sequentially could also reduce intrinsic load, as learners will have already mastered some of the knowledge they need to work out a solution in an earlier skill stage. Therefore, their research recommends beginning with a model (a complete example), gradually removing completed steps, which the learner will have to complete independently, and finally leaving just the to-be-solved problem.

These principles can be readily applied in the classroom by beginning with a model answer, then providing a writing frame/structure with a lot of information, followed by a writing frame/structure with less information, then finally a question that learners must complete independently without a writing frame.

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Key issue 2: Improve long term memory through retrieval practice - this will in turn allow more processing capacity back in the working memory

There is a great deal of very strong evidence that retrieval practice is an essential part of the learning process. Retrieval practice is the process of calling information to mind that you have been previously exposed to. By doing this, our memory for that information is strengthened and forgetting is less likely to occur. Not only is retrieval practice highly effective, but it's also very easy for teachers to implement - without the need for a huge amount of planning time, class time, financial cost or technology. With this in mind, it needs to be an established part of our day to day teaching.

In 2013 Washington University in St. Louis published a very useful paper, 'How to Use Retrieval Practice to Improve Learning' (Agarwai, Roediger, McDaniel & McDermott). This highly readable paper pulls out some of the key messages from the research about retrieval practice, that are essential in order to ensure it's successful implementation. This article picks out some of these messages.

- Teachers don't need to change their teaching style. Retrieval practice can be completely separate from your teaching, meaning that retrieval practice can be a stand alone activity e.g. start the lesson with three questions from last lesson, three from last week and three from last month.

- The more difficult the retrieval practice, the better it is for long term learning. So retrieval will be far less effective if students are allowed to look the answer up in their book.

- It doesn't need to add extra time to your teaching. Swap less effective activities with retrieval practice strategies.

- You don't need to change your curriculum, textbook or resources. Use your classroom materials to support retrieval practice questions.

- Retrieval practice is most effective when all students are expected to engage with it - not just the individual students you direct questions at.

- Don't get hung up on the best time in a lesson to do retrieval practice, or how often to do it. Try to do it as much as possible and space it out - that really makes a difference. What does seem to matter though, is that it should not be done on information that was covered in that lesson. It should be from previous lessons.

- Retrieval practice reduces test anxiety in students (67% decrease reported by students, as they are more used to the process of retrieval.

- Students need feedback on their retrieval, so they know what they know or don't know! When this feedback is more elaborate e.g. why they might have got it wrong, this appears to be even more beneficial.

- Research suggests using a variety of different questions. In real classrooms, the retrieval benefit from short answer vs. multiple choice quizzes appears to be similar.

- Homework is a great opportunity to retrieval, but again should focus on information covered in previous lessons. The difficulty with this is that you can't control the conditions they do the retrieval in e.g. they should definitely not look back through their books for the answers!

- Retrieval practice should not be given a grade - it's a learning stratgey not an assessment tool.

By using retrieval practice as a learning strategy (not an assessment tool), we strengthen our memory. Research demonstrates that this improvement in memory and long-term learning is flexible, which:

- Improves students' complex thinking and application skills

- Improves students' organization of knowledge

- Improves students' transfer of knowledge to new concepts

In other words, retrieval practice doesn't just lead to memorization – it increases understanding. Because students have a better understanding of classroom material by having practiced using this information, students can adapt their knowledge to new situations, novel questions, and related contexts.

(Taken from a blog from the Durrington Research School)

CLASSROOM PRACTICE GUIDE

NSW GOVERNMENT

DEPARTMENT OF EDUCATION

Cognitive load theory in practice

Examples for the classroom
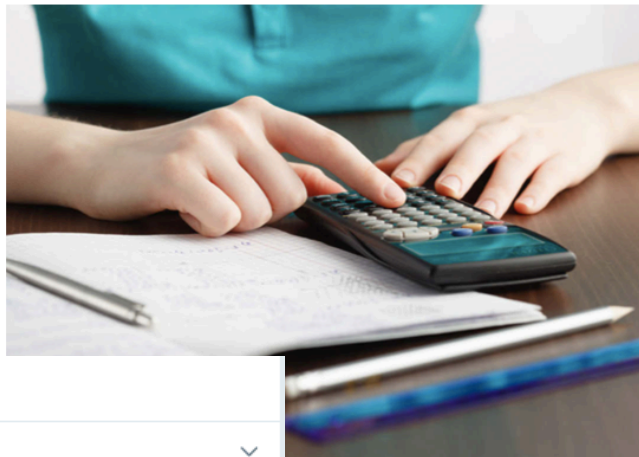
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SEPTEMBER 2017

Cognitive load theory: Research that teachers really need to understand

Centre for Education Statistics and Evaluation

Tweets   **Tweets & replies**   **Media**

Steve Garnett @Garnett_S · Jun 20
A conversation with John Sweller and Cognitive Load Theory

What You Need to Know About COGNITIVE LOAD

ELC 055: What You Need to Know About Cognitive Load
John Sweller, who formulated cognitive load theory, explains how instructional designers can design more effective learning experiences.

theelearningcoach.com

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Templates

a		n	
b		o	
c		p	
d		q	
e		r	
f		s	
g		t	
h		u	
i		v	
j		w	
k		x	
l		y	
m		z	

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Last lesson	**Last week**	**Last few weeks**	**Further back**

Last lesson	**Last week**	**Last few weeks**	**Further back**