

TEACHING MATTERS

SCIENCE OF LEARNING
NATIONAL SUMMIT

Cognitive Science in the classroom,
embedding systematic change.

Michael Roberts & Toni Hatten-Roberts



Catholic
Education
Tasmania



CATHOLIC EDUCATION
Archdiocese of Canberra & Goulburn





2012



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Efficiency and Effectiveness



When we know better, we do better.

Evidence from Cognitive Science



THE PRINCIPLES OF INSTRUCTION

TAKEN FROM THE INTERNATIONAL ACADEMY OF EDUCATION

This poster is from the work of Barak Rosenshine who based these ten principles of instruction and suggested classroom practices on:

- research on how the brain acquires and uses new information
- research on the classroom practices of those teachers whose students show the highest gains
- findings from studies that taught learning strategies to students

HOW
WILLINGHAM

- 01 DAILY REVIEW**
Daily review is an important component of instruction. It helps strengthen the connections of the material learned. Automatic recall frees working memory for problem solving and creativity.
- 02 NEW MATERIAL IN SMALL STEPS**
Our working memory is small, only handling a few bits of information at once. Avoid its overload — present new material in small steps and proceed only when first steps are mastered.
- 03 ASK QUESTIONS**
The most successful teachers spend more than half the class time lecturing, demonstrating and asking questions. Questions allow the teacher to determine how well the material is learned.
- 04 PROVIDE MODELS**
Students need cognitive support to help them learn how to solve problems. Modeling, worked examples and teacher working out loud help clarify the specific steps involved.
- 05 GUIDE STUDENT PRACTICE**
Students need additional time to rephrase, elaborate and summarize new material in order to store it in their long-term memory. More successful teachers built in more time for this.
- 06 CHECK STUDENT UNDERSTANDING**
Less successful teachers merely ask, "Are there any questions?" No questions are asked before the problems. *John*. By contrast, more successful teachers check on all students.
- 07 OBTAIN HIGH SUCCESS RATE**
A success rate of around 80% has been found to be optimal, showing students are learning and also being challenged. Better teachers taught in small steps, followed by practice.
- 08 SCAFFOLDS FOR DIFFICULT TASKS**
Scaffolds are temporary supports to assist learning. They can include modeling, teacher thinking aloud, checklists and checklists. Scaffolds are part of cognitive apprenticeship.
- 09 INDEPENDENT PRACTICE**
Independent practice produces "interleaving" — a necessary process for new material to be recalled automatically. This allows us to avoid the overload of students' working memory.
- 10 WEEKLY & MONTHLY REVIEW**
The effort involved in recalling recently-learned material embeds it in long-term memory. And the more this happens, the easier it is to connect new material to what you've already learned.

▶ Cognitive Science gives us clear indicators of what works for **all** our students to increase their learning achievement.

(Willingham 2011)

NSW Education Centre for Education Statistics & Evaluation

SEPTEMBER 2017

Cognitive load theory: Research that teachers really need to understand

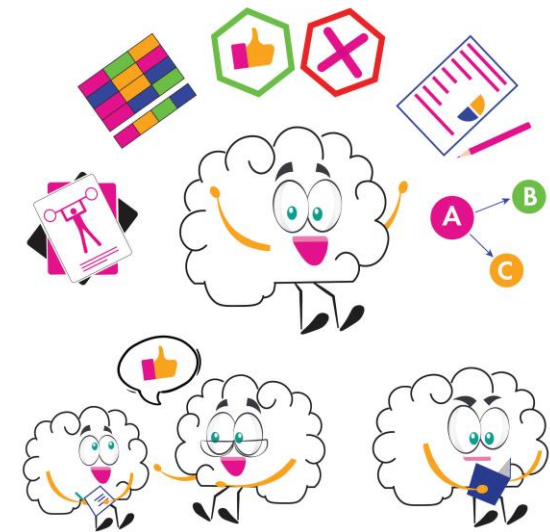
Centre for Education Statistics and Evaluation

Evidence from Cognitive Science



Cognitive pathways that support learning effectively are the same!

The evidence-based teaching methods and strategies that help all students learn

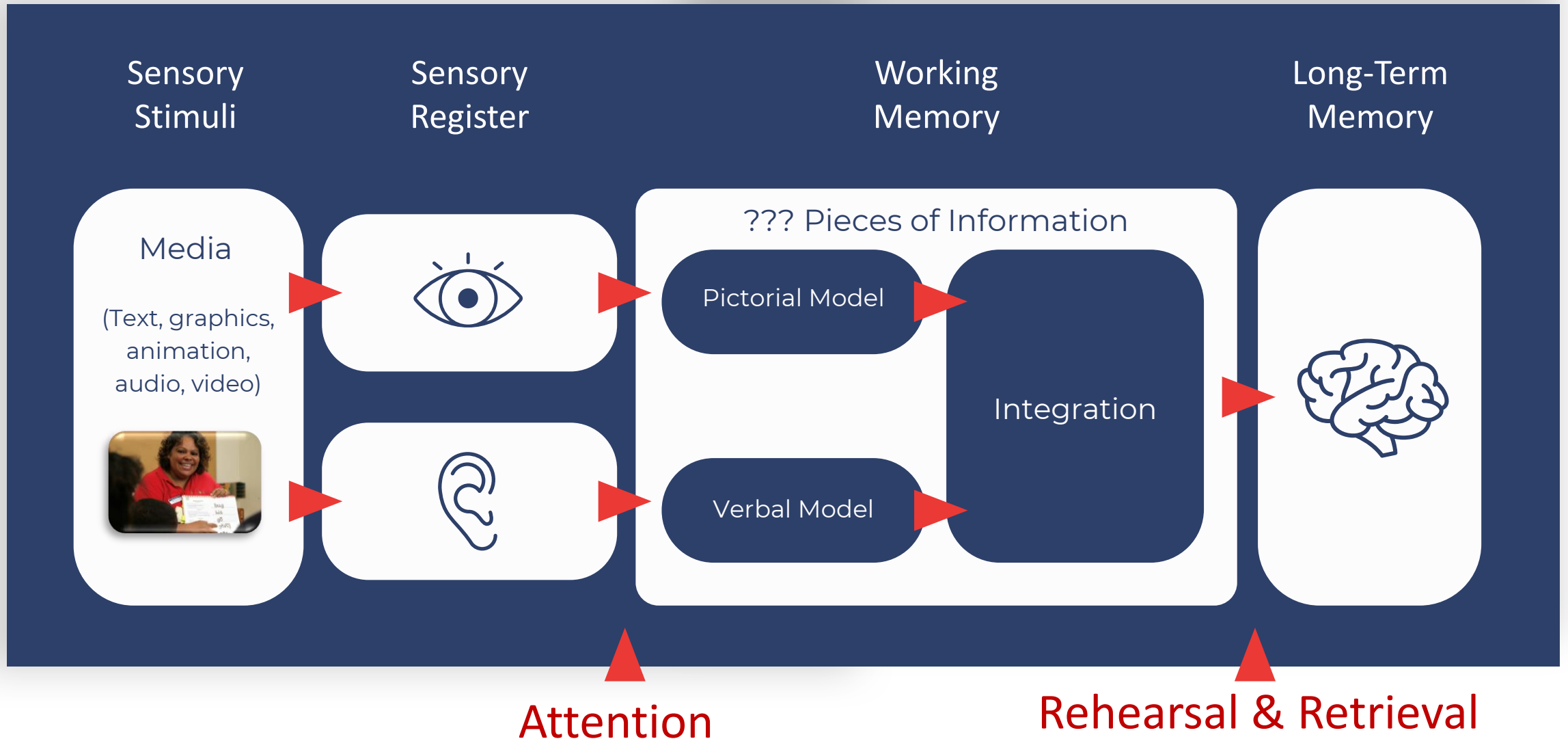


Memory & Learning

“The aim of all instruction is to alter long-term memory. If nothing has changed to long-term memory, nothing has been learned” (Kirschner, Sweller & Clarke).



Information Processing Model





N S W I B M E S L U
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N S W IB M E S L U S A
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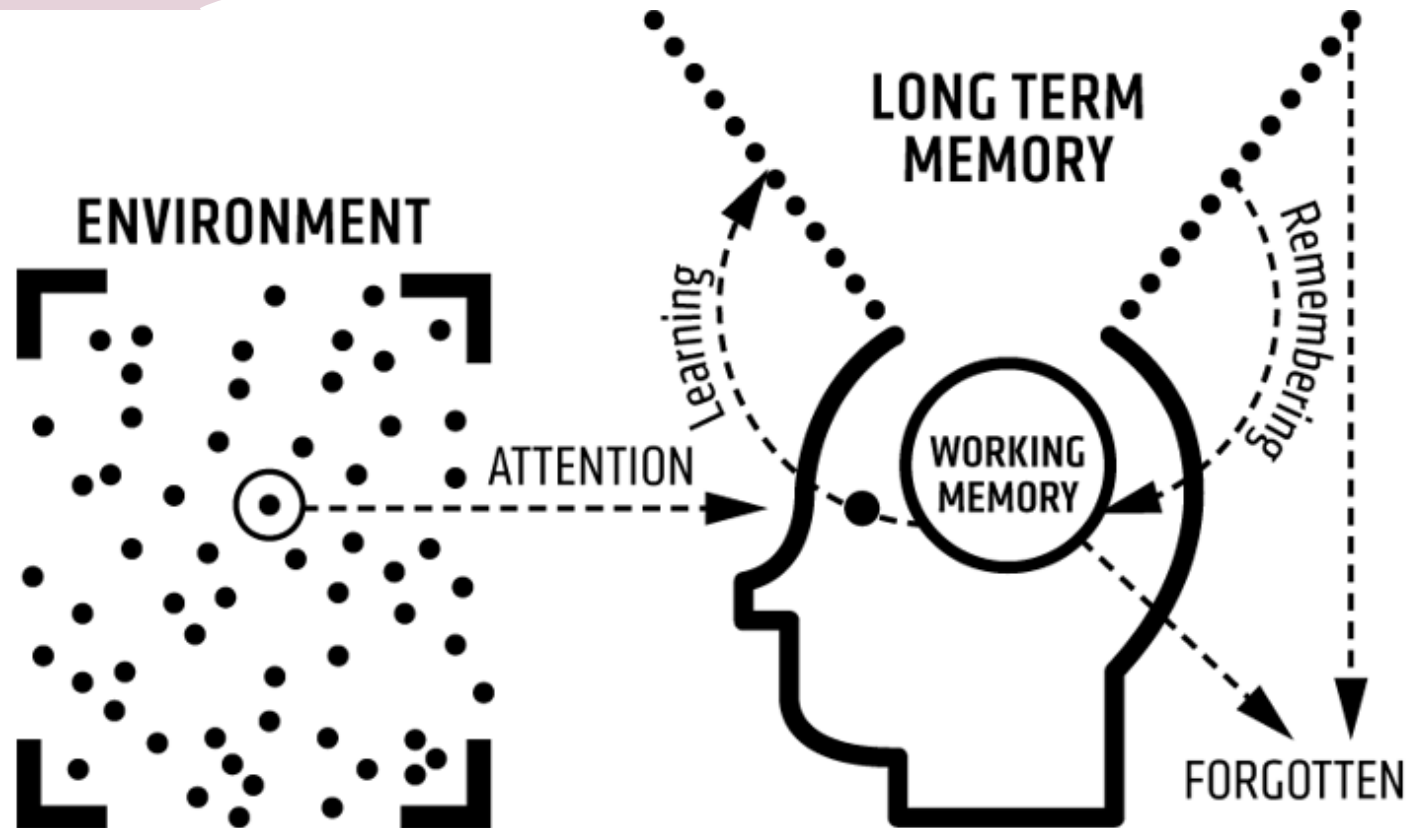
Cognitive Load Theory



Managing the
load



Memory Architecture

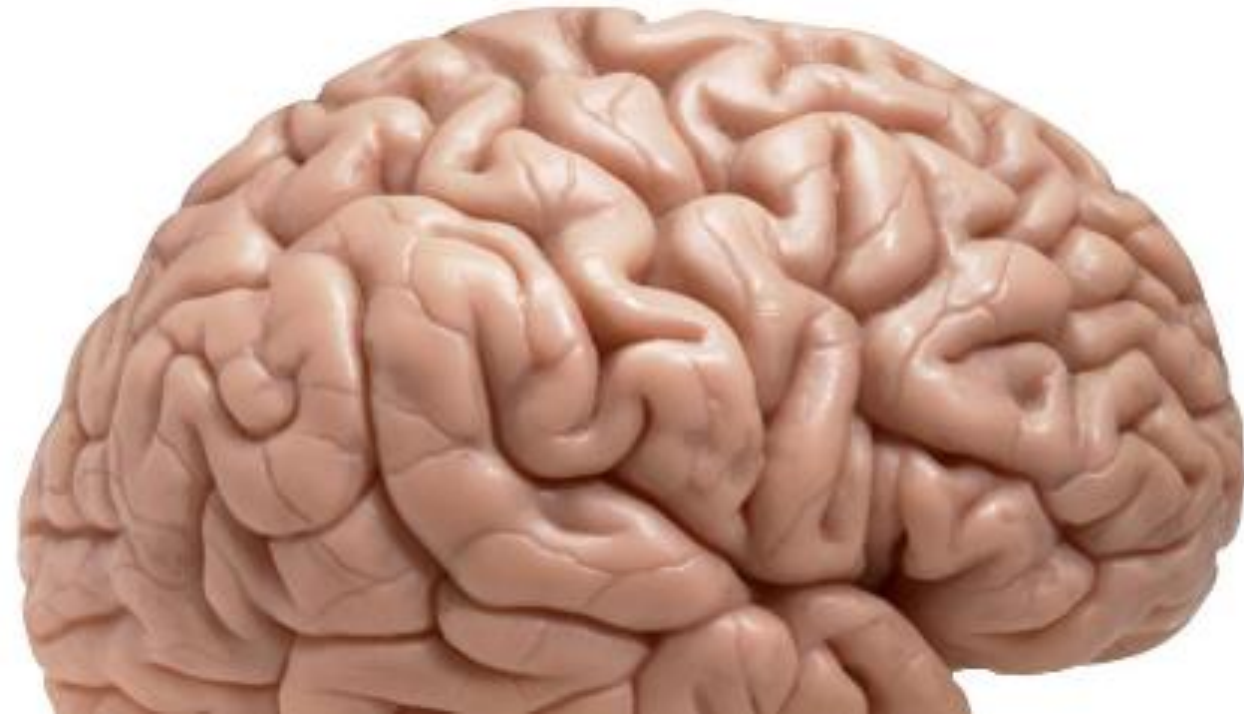


(Image: Cavigioli, 2019)

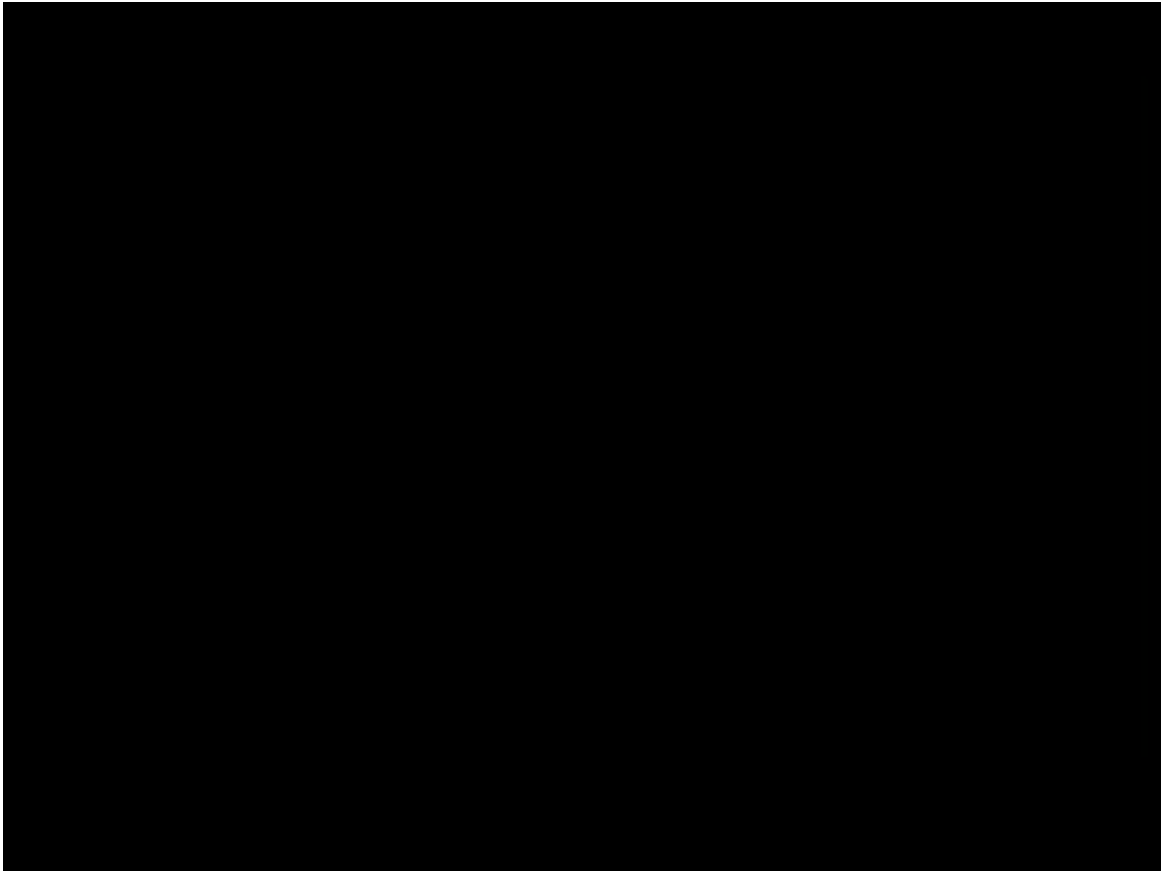
Big Ideas in the Science of Learning



- ▶ Attentional Control
- ▶ Retrieval Practice
- ▶ Rehearsal and repetition
- ▶ Dual Coding
- ▶ Spaced Learning
- ▶ Interleaved Practice



So, what are the
teaching implications
of using cognitive
science in the
classroom?



Attention

Are you paying attention?

How much of the time are you paying attention?

For the typical adult, the mind wanders 47% of the day
(Killingsworth & Gilbert, 2011)



Attention is the gatekeeper of working memory

- ▶ Guiding students' attention is key
- ▶ Set their filter
- ▶ Stress the information
- ▶ Use Gesture
- ▶ Pause and punch

ATTENTION



Declutter your instructional presentation



Enhance... not
impede
Manage student's
cognitive load by
managing the
attention



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Attentional Control - active participation



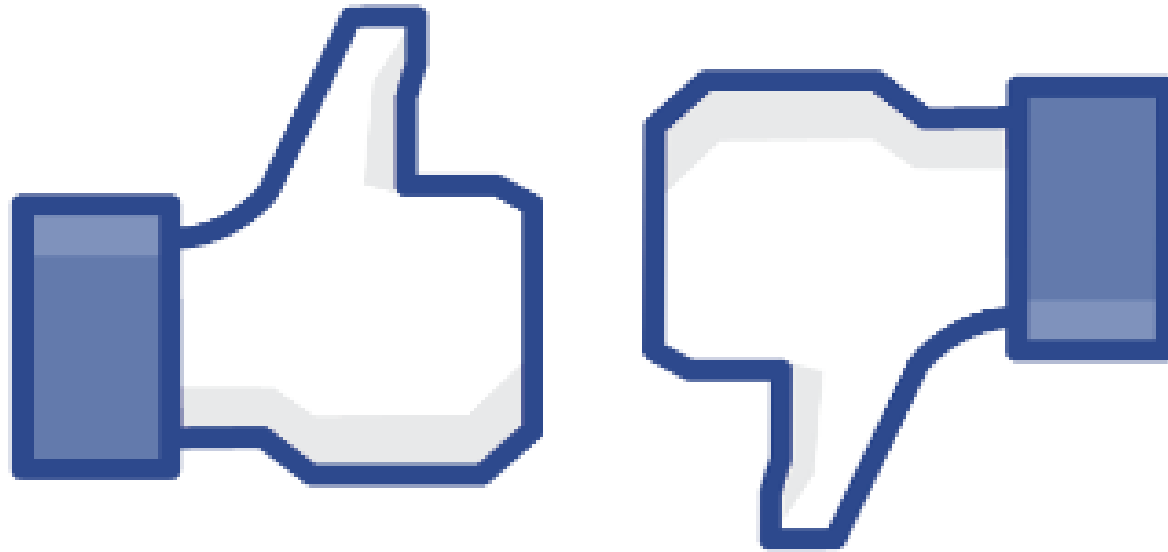
▶ White Boards

▶ Teaching Pace

▶ All students responding

▶ Verbal Rehearsal

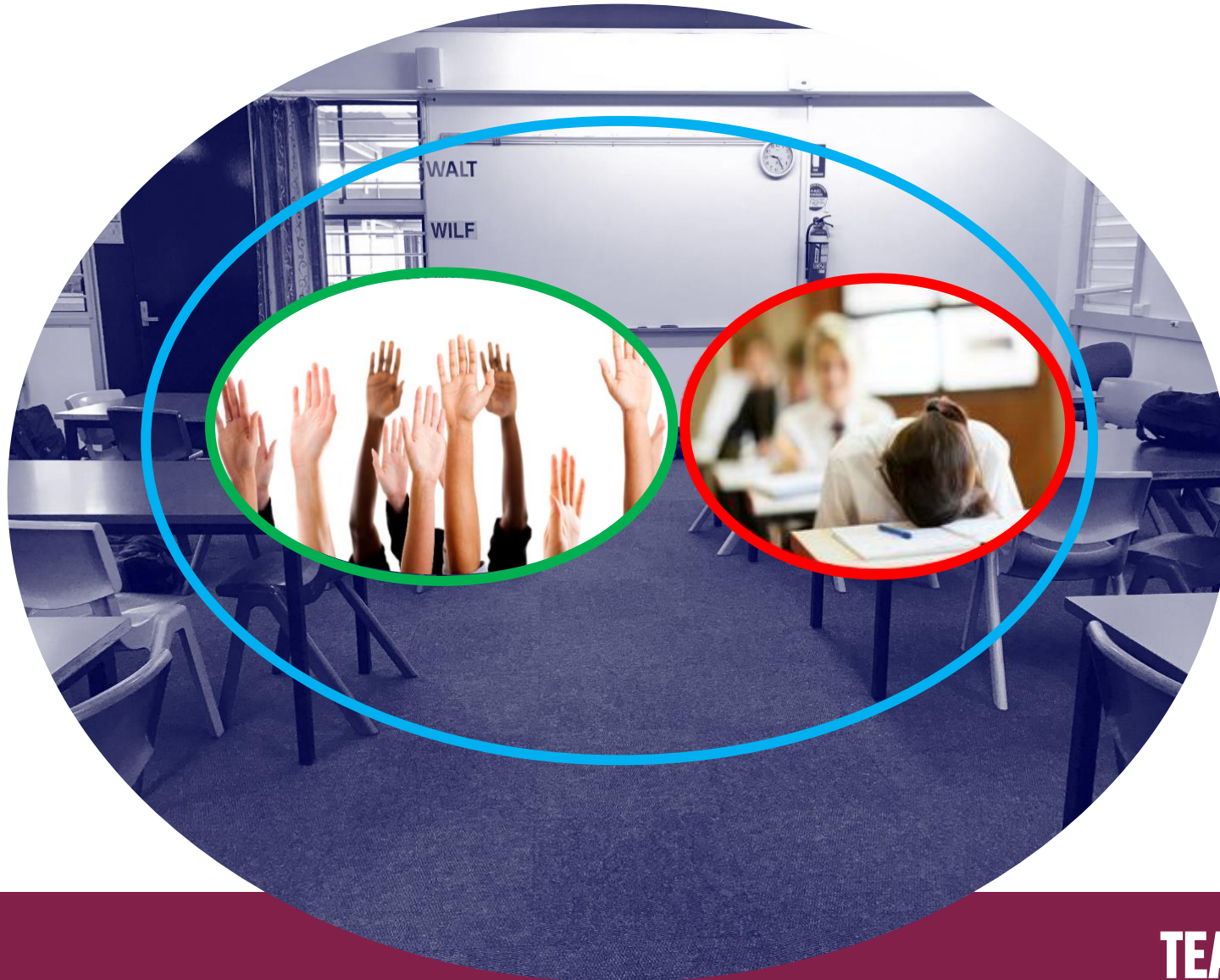
Is it okay to have a classroom where learning is optional?



Teaching Practice



Hands up creates two classrooms



- ▶ One for those who are confident and know the answer
- ▶ Or, one where, if you aren't confident or you don't know, it's okay not to participate.
(William, 2018)

Cognitive science in the classroom



The central business of teaching is about creating changes in the minds of students – in what they know, believe and how they think.

Nuthall, 2007

What are their understandings or misunderstandings?

Know the difference between “I taught it” and “they learnt it”

Active Participation – checking for understanding



▶ White Boards

▶ Questioning techniques

▶ No-hands/ all hands

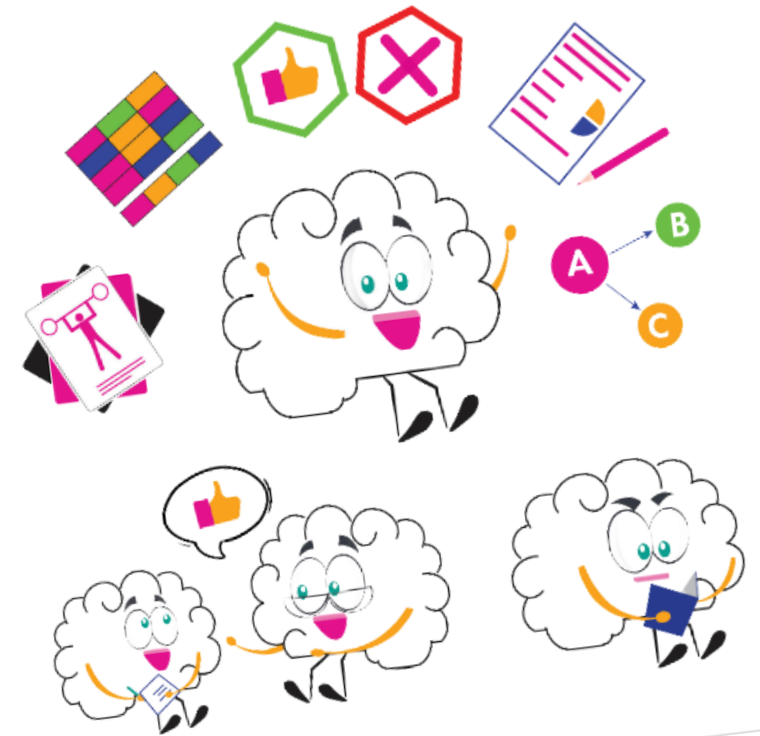
▶ Verbal Rehearsal



Retrieval Practice



- ▶ Retrieving information out of long-term into working memory
- ▶ Retrieval after some time delay (spaced) makes memories stronger and more flexible
- ▶ Effective retrieval must include check for understanding
 - see it
 - hear it
 - act it



Retrieval – cognitive science in the classroom



*Every time we draw on
memory, we increase
the knowledge
strength and extend
the longevity of the
learning.*



Retrieving = remembering
Retrieving is learning



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Memory is the residue of thought

**How can teachers help students encode information
in long-term memory?**

A or U?



Spoken to the Left	A or U	Rate for pleasantness
hundred	cool	corn
rate	jump	urge
place	country	diamond
entirely	about	welcome
into	window	aeroplane
thread	match	fruit
fleet	melt	race
training	only	winter
else	single	disease
hold	yourself	school camp



So, what happened?

- You remembered words even though you were not trying to.
- Pleasantness won because it forced you to think about what the words meant.
- Giving meaning helps with learning.
- Ask....

‘Why is this piece of information or example true or not true?’

‘Tell me how you know?’

“Tell me why”

The Repetition Key



Repetition



Automaticity



Freed
working
memory



Unlocked
understanding
& creativity

Dual Coding

The Earth has four layers.

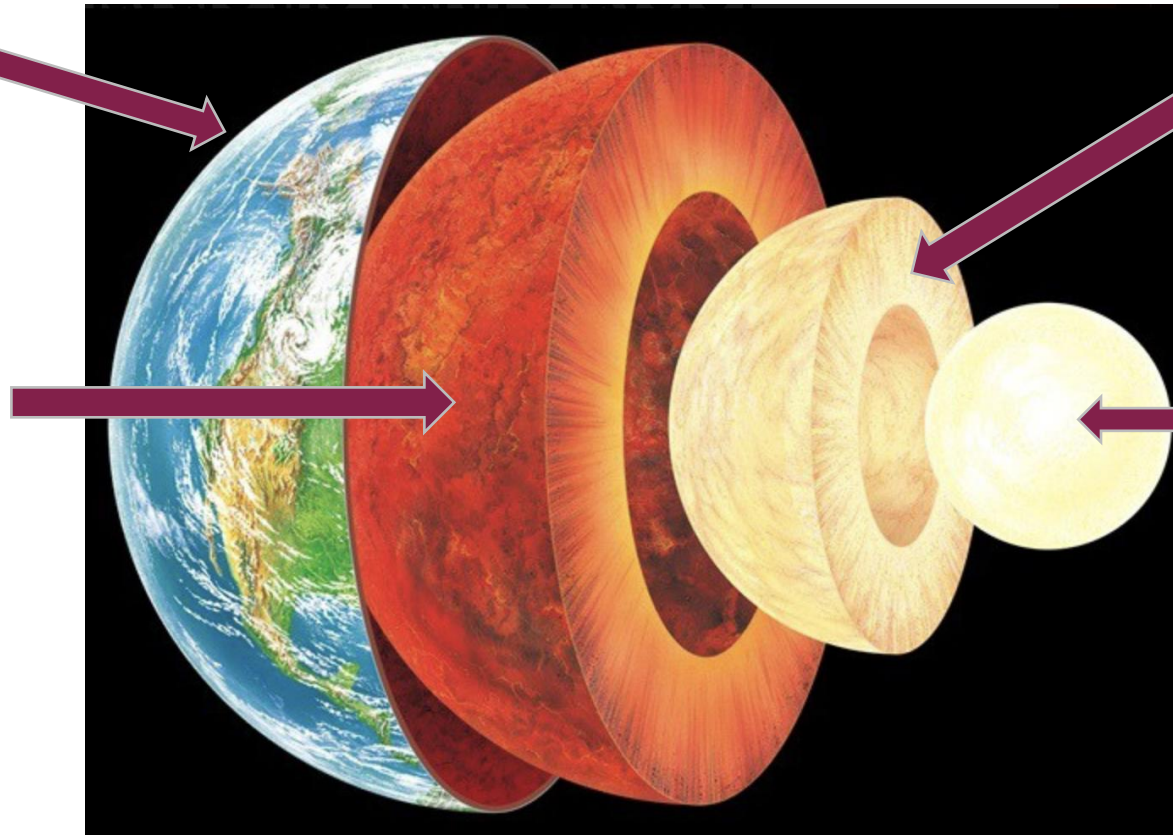
The outermost layer is the crust. The rocky layer that we live on.

A liquid outer core

A solid inner core.

Below the crust is the mantle.

It is made up of magma - molten rock.



But I taught you this?



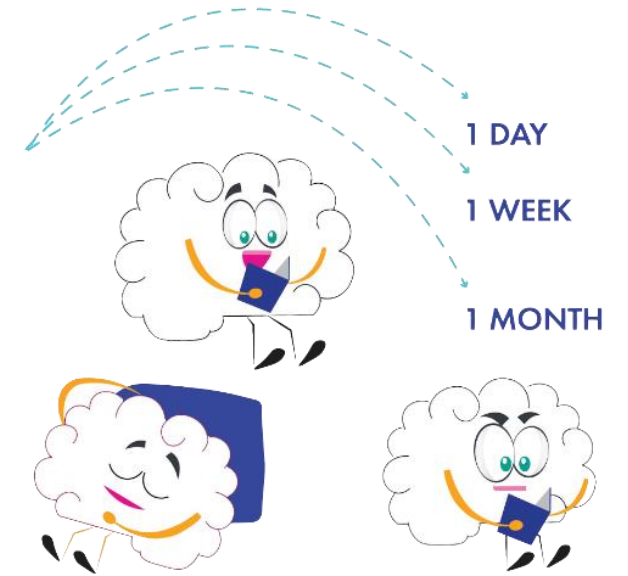
Didn't you learn this last year?

Didn't I teach you this last week?

Curriculum organisation does not allow the time for students to commit to long term memory



Spaced Learning



Spreading out learning into smaller chunks over a longer period of time, rather than block teaching.

It works by allowing information to be slightly forgotten and then repeatedly, effortfully retrieved.

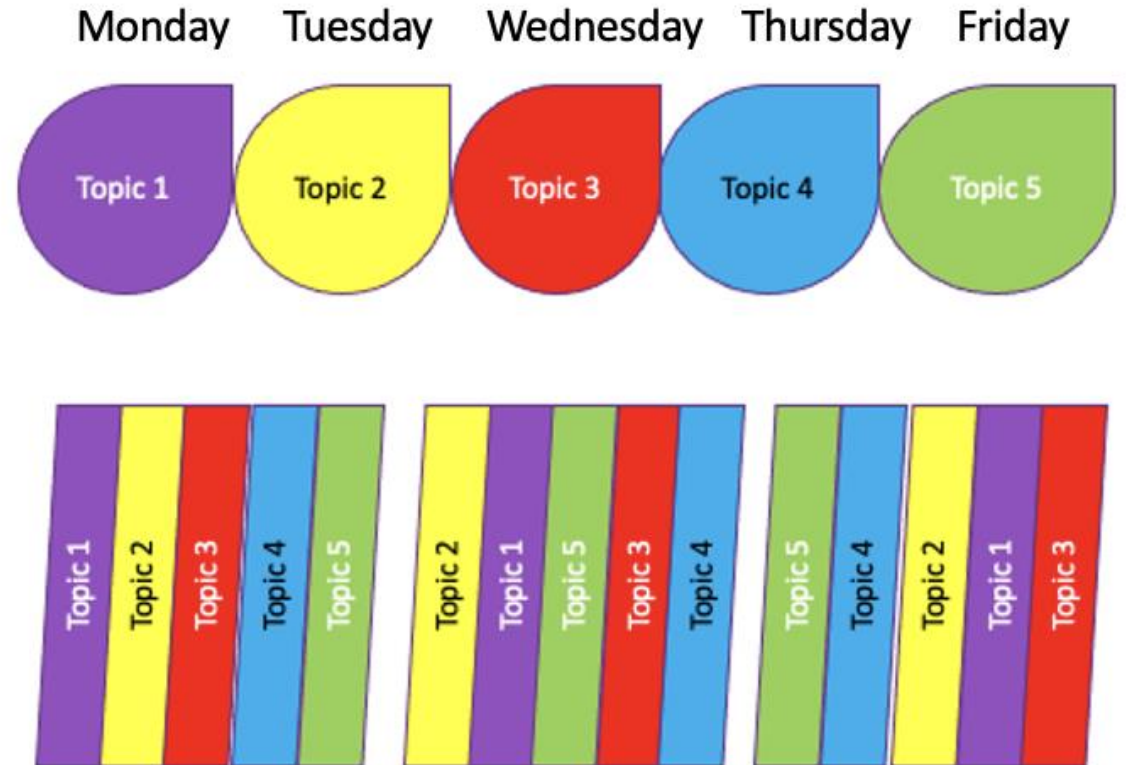
Why?

Same time

Same effort but remember
more

Interleaving

- ▶ Paired with Spaced Learning
- ▶ Deliberate design of our content and delivery





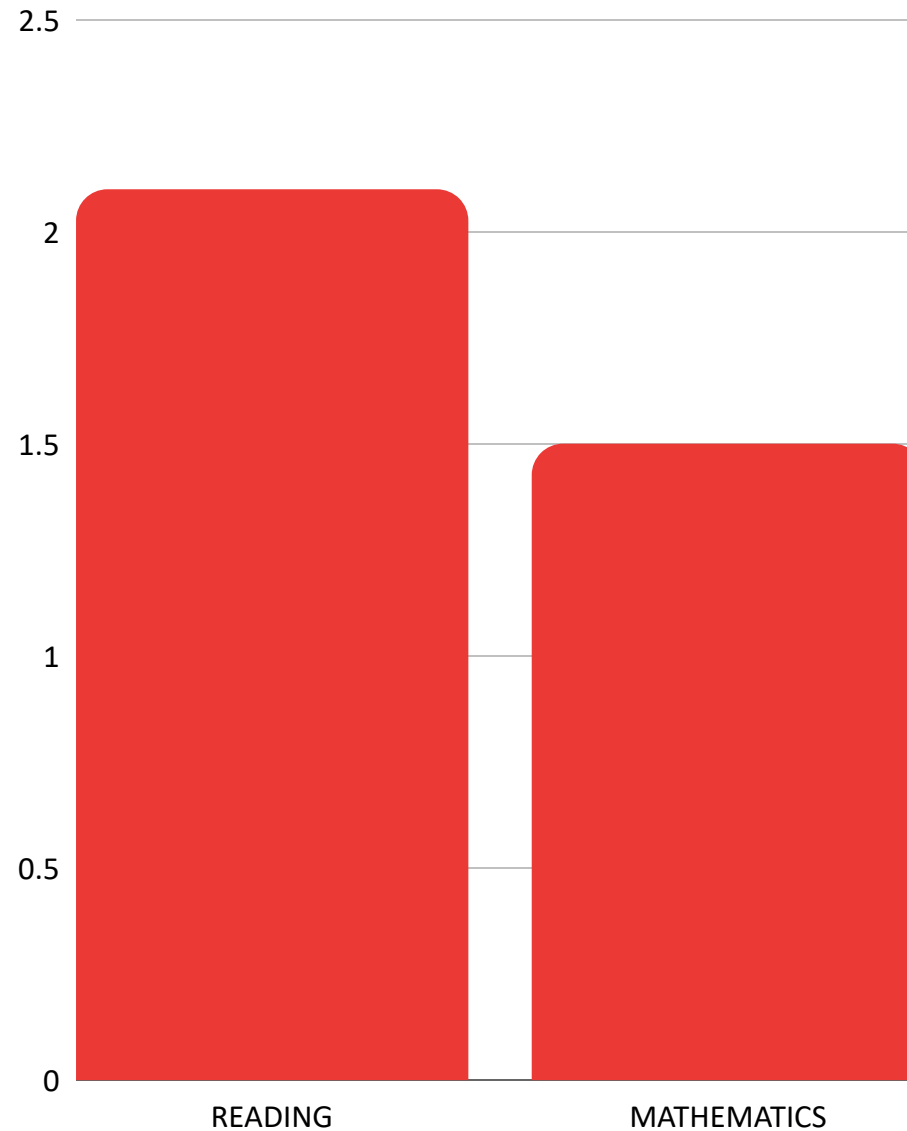
How do we get great teaching?

Mastery Teaching should be at the core of a school's approach.

- 1 A clear Pedagogy
- 2 Aligned structures
- 3 High expectations
- 4 Coaching - feedback rich culture

Does It Work?

Data collected from Mastery Schools Australia students in 2022 shows us that the average improvement rates were 2 years, 1 month for Reading and 1 year, 5 months for Mathematics



Embedding Systematic Change

- ▶ Build a school on evidence – **The Science of Learning**
- ▶ Align all school structures with, and around this.
- ▶ Hold teachers & students to incredibly high expectations
- ▶ Invest in professional development and **coaching** as a core priority