TEACHING MATTERS
SCIENCE OF LEARNING NATIONAL SUMMIT

Science of Learning in Mathematics

Jordan O'Sullivan

Shaping Minds
The science of learning meets the art of teaching

Catholic Education Tasmania

CATHOLIC EDUCATION

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In this session…

- Cognitive Science
  - Information Processing Model
  - Cognitive Load Theory
- Four Instructional implications flowing from the above

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Information Processing Model

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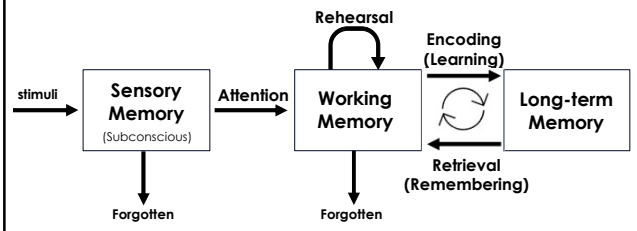
Information Processing Model



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Cognitive Load Theory

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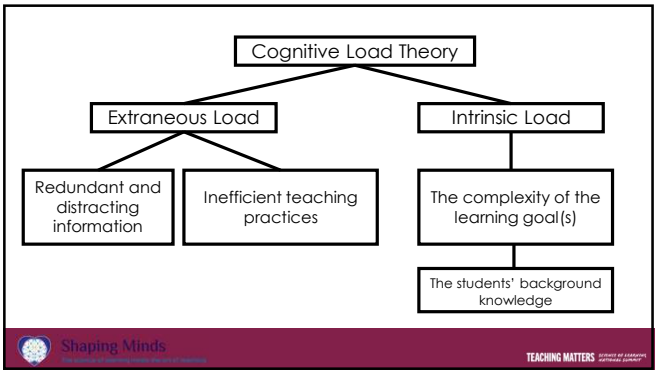

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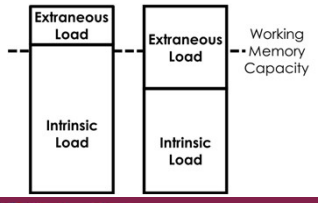
Cognitive Overload

When the sum of extraneous and intrinsic load exceeds working memory capacity



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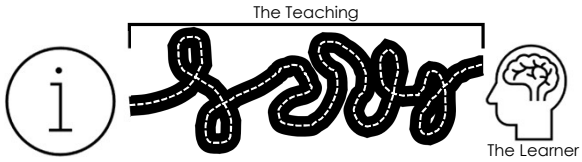
High Extraneous Load: Inefficient Teaching



The extra mental work that the student needs to do to understand the information, as a result of inefficient or ineffective instruction, is extraneous load

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Inquiry & Cognitive Load

"Any instructional theory that ignores the limits of working memory when dealing with novel information is unlikely to be effective… **inquiry-based instruction places a huge burden on working memory**."

Kirschner, Sweller & Clark, 2010

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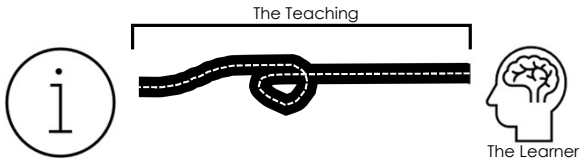
Low Extraneous Load: Efficient Teaching



When teaching is efficient and aligns with the science of how humans learn, students don't need to do as much unnecessary mental work to understand the information.

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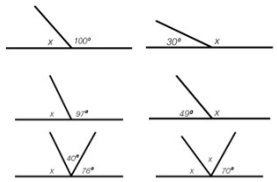
Important Term: 'Variation'

For a skill that you teach, there are sometimes different 'ways' that the skill needs to be applied, or slight increases in difficulty for the same skill. These are '**variations**' of the skill.

Calculating Supplementary Angles



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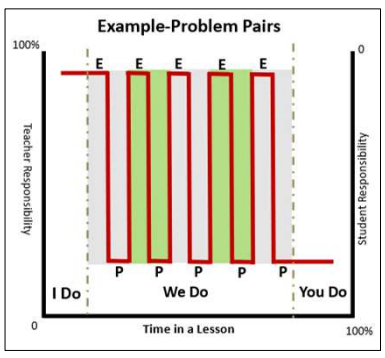

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Teacher	Students
Draw a rectangle and shade $\frac{2}{5}$ two fifths	Draw a rectangle and shade $\frac{4}{5}$ four fifths

Step 1: Draw the shape.
Step 2: Check the denominator and divide the shape into that many equal parts.
Step 3: Check the numerator and shade that many equal parts.

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Teacher	Students
Draw a rectangle and shade $\frac{3}{8}$ three eighths	Draw a rectangle and shade $\frac{7}{8}$ seven eighths

Step 1: Draw the shape.
Step 2: Check the denominator and divide the shape into that many equal parts.
Step 3: Check the numerator and shade that many equal parts.

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65 – 38 = ___

	tens	ones
–		

75 – 28 = ___

	tens	ones
–		

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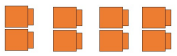
We Do I do ⇨ You do

$4 \times 2 = \_\_$

__ groups of __ = __

__ + __ + __ + __ = __



We Do You do ⇨ I do

$5 \times 2 = \_\_$

__ groups of __ = __

__ + __ + __ + __ + __ = __

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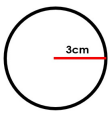
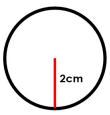
We Do

What is the circumference of this circle?



What is the circumference of this circle?



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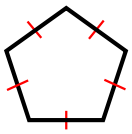
We Do

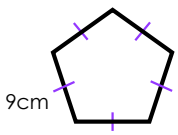
Steps

1. Check that it is a regular polygon.
   - ***Hint:*** *are all the sides the same length?*
2. Determine how many sides there are.
3. Multiply the side length by the number of sides.
4. Write your answer with the unit of measurement.

Teacher Calculate the perimeter



Students Calculate the perimeter



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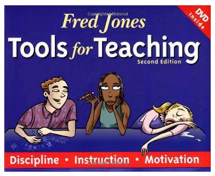
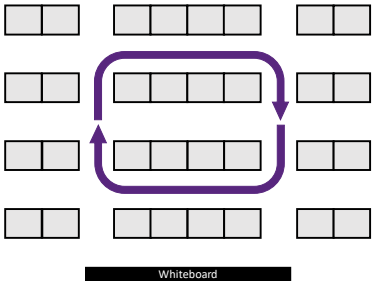
Classroom Arrangement Matters





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Daily Review

A fast-paced session in which the teacher leads spaced practice and retrieval practice of a range of facts and skills.

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What goes in a Daily Review?

1. Facts and skills to-be-automatised.
2. Facts and skills relevant to the lesson that follows (if applicable).*

*Because Activating Prior Knowledge is part of an explicit lesson design, point 2 is less of a focus for Daily Review than point 1

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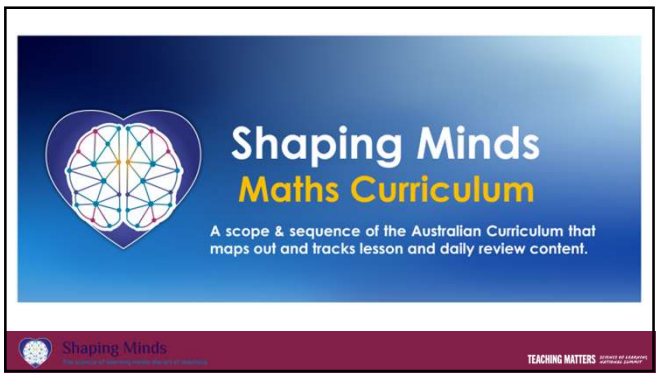

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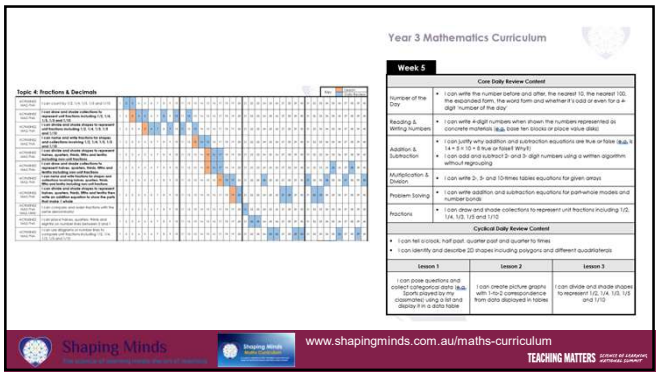

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Practical Implications

1. Make your instruction efficient by using worked examples.
2. Present information and arrange your classroom in a way to minimises distractions for students.
3. Break complex learning goals into 'instructional units' so that they can be committed to long-term memory.
4. Dedicate time to leading spaced practice and retrieval practice of a range of Maths facts and skills (Daily Review).

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