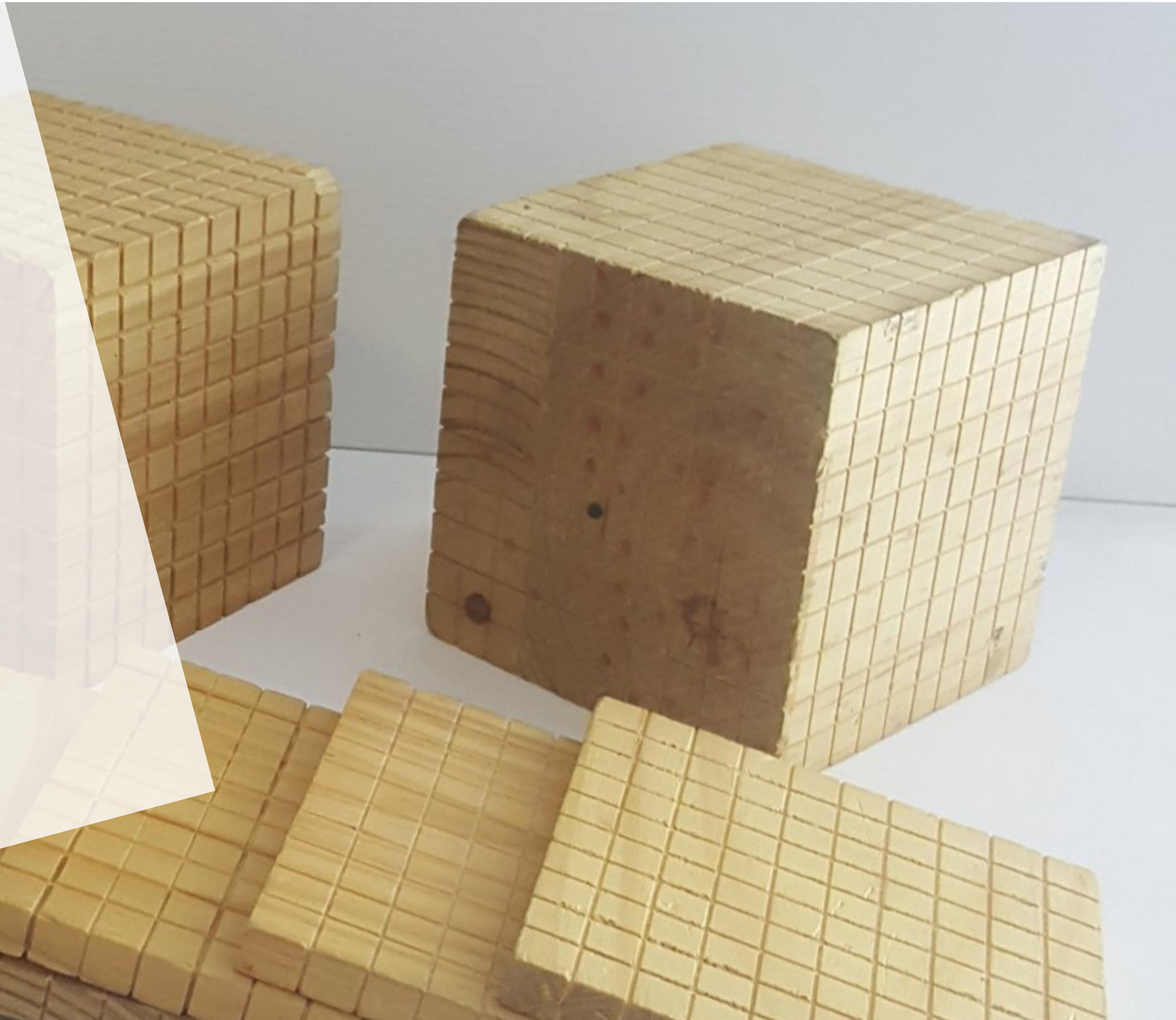
THE UNIVERSITY OF MELBOURNE

Strategies to support learners with SEN in the Maths Classroom



Catherine Pearn
Matthew Harrison

Overview of our session

1. Welcome & introducing ourselves **2 mins**
2. Setting the scene – an example of the Mathematics Online Interview **3 mins**
3. Using Cognitive Load Theory to think about supporting all students **25 mins**
4. Maths Intervention for students at risk **20 mins**
5. Q and A about specific challenges **10 mins**

Introducing Matthew Harrison

My background:

- Teacher (F-12 & Tertiary) in Australia, the UK and South Korea
- Experience in both ‘mainstream’ and specialised SEN settings
- Lecturer & researcher @ the MGSE in autism and digital technologies
- @hattdesigns

Introducing Cath

- Is a lecturer in Mathematics Education at the University of Melbourne.
- She has had extensive teaching experience in primary schools and tutored many secondary students across the range of mathematics subjects.
- Cath is also a Senior Research Fellow in the ACER Institute. In this role she has written, delivered and reviewed programs for Australian primary and secondary classroom teachers.
- She planned and delivered leadership programs for the Bastow Institute and Department of Education and Early Childhood (DEECD).
- She was the Numeracy Advisor for the review of mathematics courses for the Solomon Islands School of Education.
- Cath has been involved in research projects investigating how students learn mathematics at the early childhood, primary, secondary and tertiary levels, particularly students mathematically “at risk”.
- Her current PhD research is looking at the links between fractional competence and algebraic thinking.

An example of the Mathematics Online Interview

Learning intervention

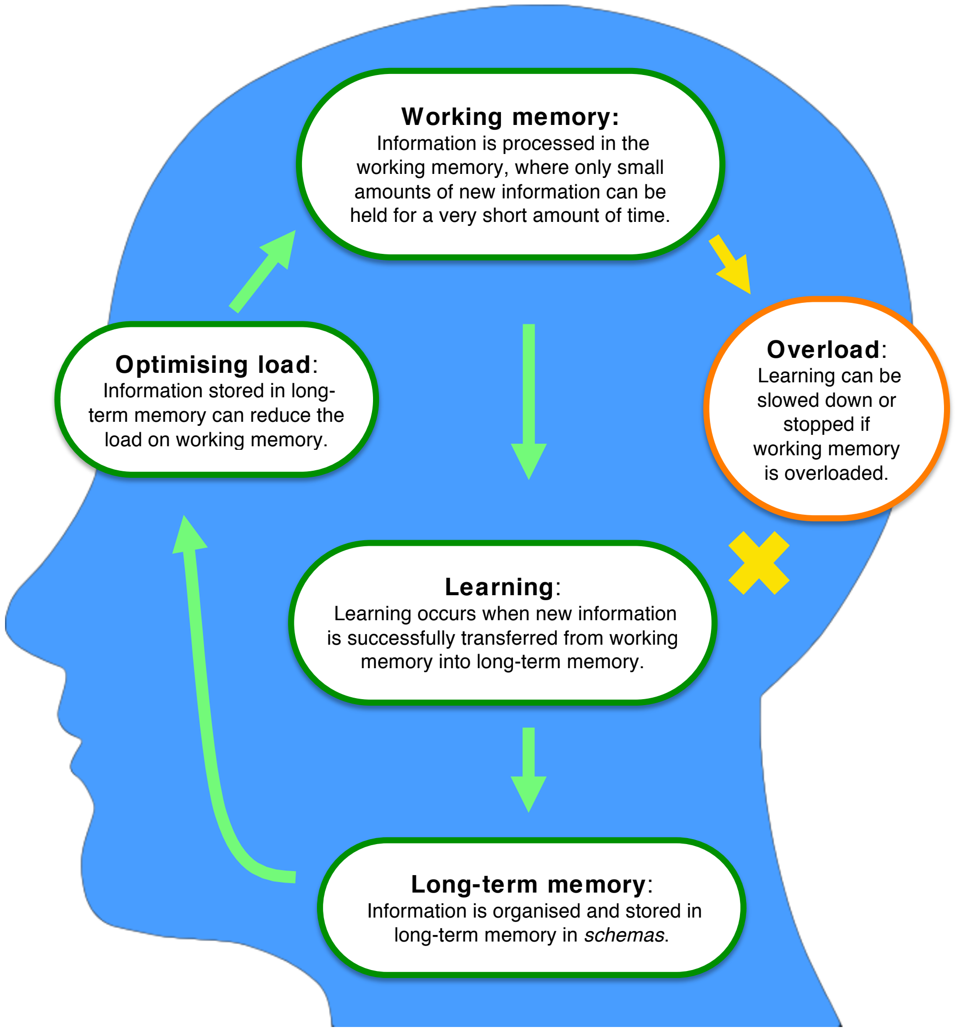
- What is the difference between **learning intervention** and **special education**?
- Why does it matter?
- Labels of disability versus **functional needs**

A key learning theory 'take away'

Cognitive Load Theory

Cognitive Load Theory

New information
The human brain can only process a small of amount of **new** information at once.



Stored information
The human brain can process large amounts of **stored** information at once.

New information and working memory

- New or unfamiliar information is initially processed in a learner's working memory. Only **small amounts of information** can be retained for a **limited time** while it is being processed in a learner's working memory (Sweller, Ayres & Kalyuga, 2011).
- Adults can retain somewhere between **five to eight individual pieces of information** at once but can only simultaneously **process** a maximum of **four** of these (DENSW, 2018).
- It is argued that while this can be increased by chunking through the use of patterns, categories, and groupings (Ang, Zaphiris & Mahmood, 2007; Preece, Rogers & Sharp, 2002), these strategies are not intuitive and **need to be developed** (DENSW, 2018).
- For learners with **cognitive impairments**, such as Down syndrome, both the **period of retention** and the **amount of information** that can be processed can be significantly **lower** (Blanck, 2014).

Learning as processing information

- Cognitive Load Theory focuses on the role of processing at an individual level in the learning process.
- Cognitive Load Theory argues that learning occurs when information is successfully **transferred** from a learner's working-memory to their long-term memory (DENSW, 2018).
- It is vital that key new information is processed and transferred to long-term memory in order allow a learner to process further new information.

Long-term memory, stored information and optimising load

- While the capacity of working-memory is extremely limited, long-term memory stores information using knowledge structures, or '**schemas**', allowing for the processing of large amounts of information (Sweller, Ayres & Kalyuga, 2011).
- A schema is "a pattern or guide for representing an event, a concept *(knowledge)* or skill" (Woolfolk & Margetts, 2016, p. 260).
- The complexity of a schema can vary from a few pieces of information to a highly complex organisation containing an enormous amount of information (DENSW, 2018).
- Information stored in long-term memory in schemas **reduces the load on working memory**, as capacity limitations only apply when processing new or unfamiliar information (Sweller, Ayres & Kalyuga, 2011).

What contributes to cognitive load?

Three kinds of cognitive processing during learning that can contribute to cognitive load:

1. **Intrinsic** (or essential) **processing**: The learner engages in cognitive processing that is essential for comprehending the material.

2. **Germane** (or generative) **processing**: The learner engages in deep cognitive processing such as mentally organising the material and relating it to prior knowledge. This depends on the learner's **motivation** and **prior knowledge**, as well as prompts and supports in the lesson.

3. **Extraneous processing**: The learner engages in cognitive processing that **does not support the learning** objective. An example of this being increased is students being confused by poorly labelled diagrams.

- Adapted from DeLeeuw and Mayer (2008, p. 223)

Cognitive Overload

- If a learner's working memory is at full capacity and they then attempt to process additional information, cognitive overload occurs (Ang et al., 2007). = **Processing slows/stops** 😣
- Undesirable emotional consequences of cognitive overload include stress and frustration. **= Established link between overload and behaviour** 😡
- When working with students with a **reduced working memory** capacity, it is particularly important to be aware of the cognitive overload.
- Spaced instruction reduces the amount of new information being processed by the learner's working memory, affording **processing time** for this information to be stored and organised within schema in their long-term memory.

Take away message

- When designing a lesson it is important that **strategies** and **supports** are used that afford **intrinsic** and **germane processing** by the learner, while reducing extraneous processing.
- This provides the most efficient transfer path from working memory to long-term memory for the key concepts being targeted by the lesson.

	Strategy	Rationale
Explicit instruction	1. Tailor lessons according to students’ existing knowledge and skill	Students learn best when teachers tailor lessons to their existing knowledge and skill (DENSW, 2018, p. 5).
Explicit instruction	2. Use worked examples to teach students new content or skills	Students learn new content or skills best when they are given lots of worked examples (DENSW, 2018, p. 11).
Explicit instruction	3. Cut out inessential information	Students do learn effectively when their attention is directed to inessential information (DENSW, 2018, p. 19).
Explicit instruction	4. Present all the essential information together	Students do not learn effectively when their limited attention is split between two or more sources of essential information that have been separated (DENSW, 2018, p. 23).
Explicit instruction	5. Simplify complex information by presenting it both orally and visually	Student can process complex information more easily when it is presented in both oral and visual forms at the same time (DENSW, 2018, p. 27).
Explicit instruction	6. Encourage students to visualise concepts and procedures that they have learnt	Encourage students to visualise concepts and procedures that they have learnt (DENSW, 2018, p. 31).
	7. Gradually increase independent problem-solving as students become more proficient	Students benefit from gradually being given more opportunities for independent problem-solving to practise using knowledge and skills they have learnt (DENSW, 2018, p. 15).

Supporting learners with social emotional disabilities/differences/challenges

Systems and **routines** help all students understand their classroom environment

Mathematics intervention for students with additional needs

Activity: Characteristics of struggling and thriving students

Characteristics of struggling students

Characteristics of thrving students

Students struggling with mathematics

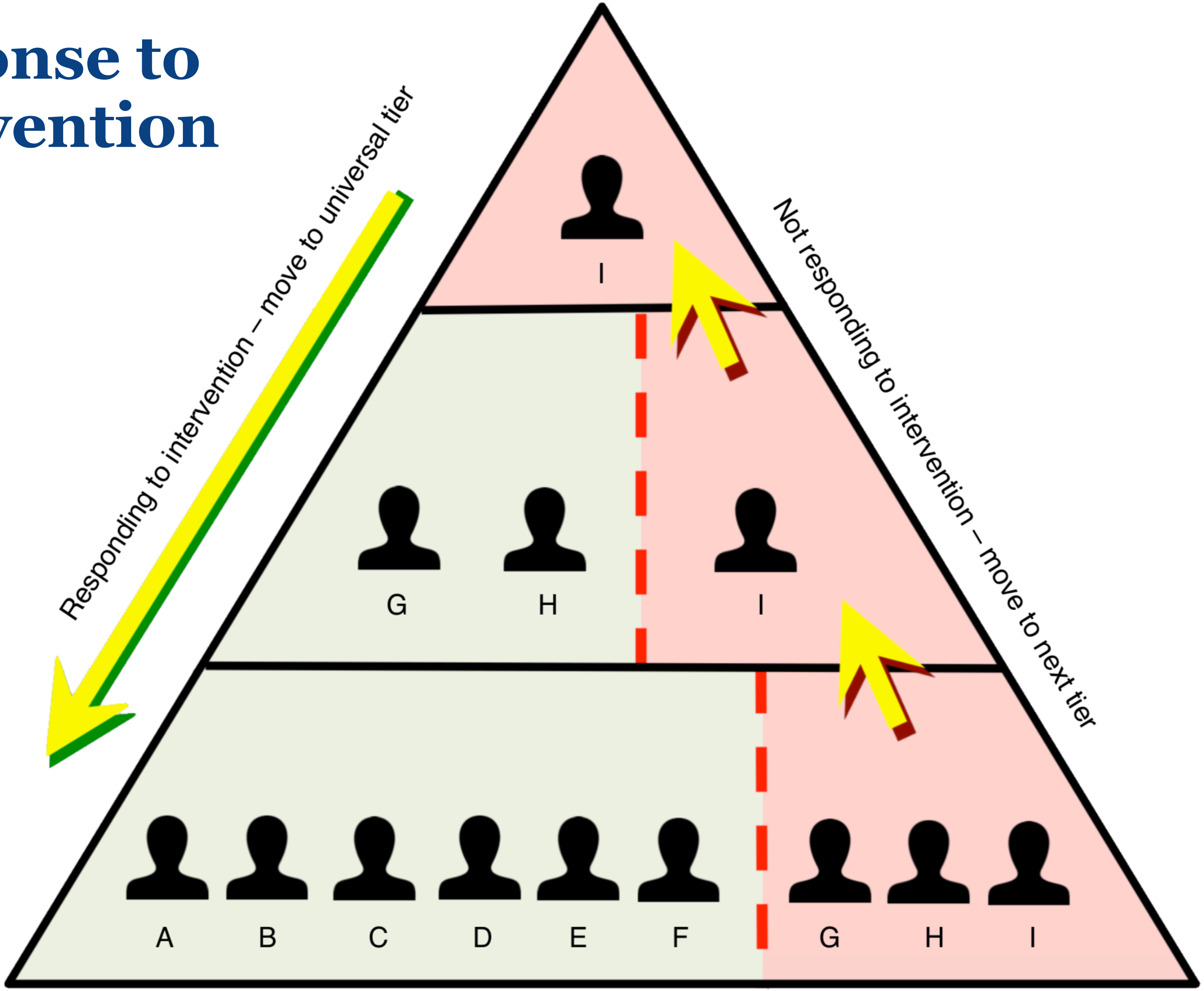
- Students struggling with mathematics are usually:
  - dependent on the procedure - counting and limited to the "count-all" and "count-back" procedures (procedural thinkers)
  - use inefficient strategies - tally marks
  - incorrect procedures
  - have many misconceptions - zeros

Students thriving in mathematics

Students doing well in mathematics usually:

- know which processes to use and understand the concepts (proceptual thinkers)
- use most efficient strategies for the task
- apply the correct procedures
- check that their responses are reasonable
- have a range of known facts
- use known facts to derive other facts

Response to Intervention



Mathematics Intervention

- In 1993 Mathematics Intervention started as a collaborative project with staff from Bulleen Primary & La Trobe University
- Based on research about children's early arithmetical learning
- Aimed to identify, then assist, children in Year 1 'at risk' of not succeeding in mathematics **(think Tier 2)**
- Used clinical interview techniques for assessment and teaching
- When Bulleen Primary was closed the program was taken to Boroondara Park Primary School (1994)

Mathematics Intervention

- is a withdrawal program
- children work in small groups
- develops basic concepts of number
- depends on teacher having the skills to:
  - recognise that child has a problem
  - identify the extent of the problem
  - have the expertise to assist overcome the problem

Counting Stages

1. *Perceptual*. Students are limited to counting those items they can perceive.

2. *Figurative*. Students count from one when solving addition problems with screened collections. They appear to visualise the items and all movements are important.

3. *Initial number sequence.* Students can now count on to solve addition and missing addend problems with screened collections.

Counting Stages (cont.)

4. *Implicitly nested number sequence.* Students focus on the collection of unit items as one thing, as well as the abstract unit items. They can count-on and count-down, choosing the most appropriate to solve problems.

5. *Explicitly nested number sequence*. Students are simultaneously aware of two number sequences. They understand that addition and subtraction are inverse operations.

Common difficulties in Year 1

- difficulties elaborating the number sequence
  - confusion with teen and ty words
  - counting backwards
  - bridging decades
- little or no one-to-one correspondence
- difficulty with mathematical symbols
- confusion with mathematical language
- lack of efficient strategies

Common challenges in Year 3/4

Large number of Years 3 & 4 students used inefficient counting strategies for both types of assessment. This was evidenced by:

- finger tapping
- tally marks
- blinking
- use of repeated addition and subtraction

Large differences in scores:

- Basic Number Fact Tests
- Number Screening Tests especially word problems
- between classes

Teaching strategies

- start from what student knows
- provide range of appropriate materials
- students draw or represent materials
- ask questions: “How did you do that?”
- expect students to explain strategies
- use alternative solution strategies
- patient, praise, encourage risk taking, appreciate differences

What else do we need to consider for students with additional needs?

- language
- verbal sequence
- number sense
- strategies
- dependent learners
- affective factors
- class tasks
- assessment tasks

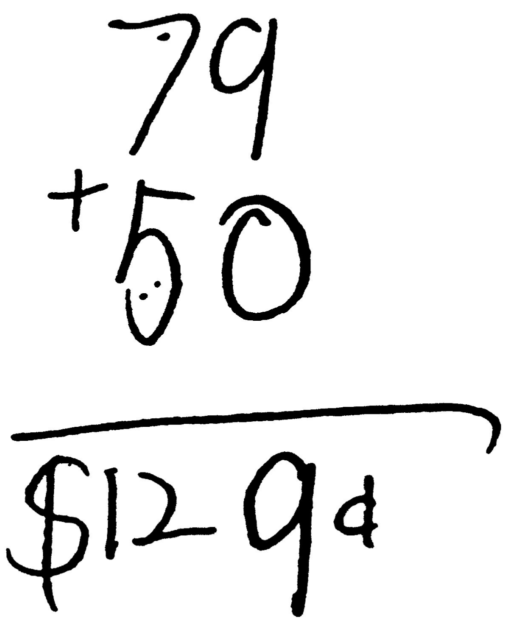
Year 3 student struggling with addition

Need to check that number facts are known (and used)

- to 10
- to 20

Can students model 2 and 3 digit addition with concrete materials?

Can students articulate mental strategies?



Year 3 student struggling with multiplication

"groups of …"

- make
- draw
- estimate
- calculate

arrays

grids

tables – need understanding of multiplication before rote learning

Year 3 student struggling with division

“How many groups of …?”

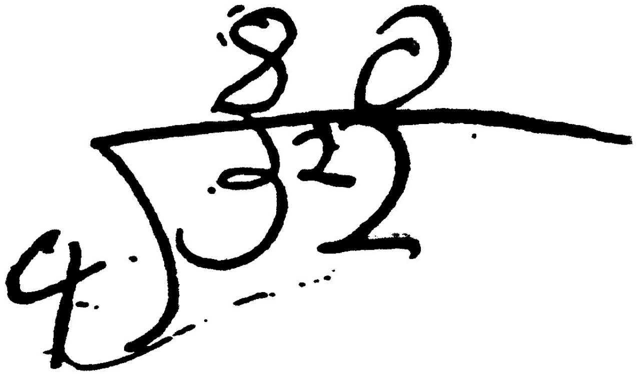
- make
- draw
- estimate
- calculate

sharing is innate

arrays

multiplication chart to solve division

times tables



Teaching Mathematics

- There is no preferred way to teach mathematics, but most successful share the following characteristics.
- teach from a base of concrete experience
- recognise mathematics as abstract & general
- use a variety of modes of classroom activity
- emphasise applications
- recognise:
  - individual differences,
  - different learning preferences

Approaches to teaching & learning (cont.)

- Emphasise the sensible use of mathematics
  - checking the reasonableness of results
  - choosing & using tools appropriately & effectively
  - being alert to finding reasons why ideas do, or do not, work

- Allow time for growth

Questions?

Read the full report!

Department of Education New South Wales [DENSW]. (2018, November). **Cognitive load theory in practice: Examples for the classroom** [Online document]. Centre for Education Statistics and Evaluation. Retrieved from https://www.cese.nsw.gov.au/images/stories/PDF/Cognitive_load_theory_practice_guide_AA.pdf

Thank you