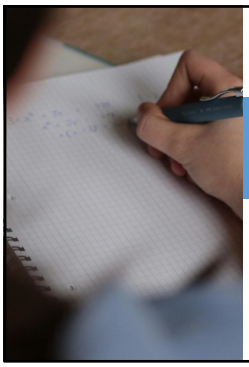

HDST Training Presentation

Written by Remona Mekdessi Sarkis

Allied Health and Mathematics

June 2025

1

Recommended Pre-Reading

1. Maths + Language = Speech Pathologists! (2016) https://www.freospeech.com.au/single-post/2016/11/14/maths-language-speech-pathologists
2. My child used to be so good at maths. What happened? (2016) https://www.banterspeech.com.au/my-child-used-to-be-so-good-at-maths-what-happened/
3. How can Speech-Language Pathologists Support Students with LDs to Learn Math? (2019): https://www.ldatschool.ca/ate-slp-math/

2

What it takes to answer a math question

Construct a rhombus with side lengths of 5 cm.

- What is required to answer this question?

Source: Majewska (2021): https://www.cambridgemaths.org/blogs/the-language-of-mathematics/

3

What it takes to answer a math question

Be able to read and comprehend the question (spoken/written)
Know what "construct" actually means
Know what "construct" means in the context of this question
Know what a "rhombus" is
Know what '5' is as a quantity
Know what cm is
Know what 5cm is
Relate 'construct' with '5cm' and determine what equipment is required (HLL)
Write/"construct" an accurate response

Source: Majewska (2021): https://www.cambridgemaths.org/blogs/the-language-of-mathematics/

4

Summary of key themes from pre-readings

- Mathematical vocabulary
  - Mathematical sums are like a " "sentence" with nouns (numbers) and verbs (operations)" (Freospeech)
  - Understand influence of operations on numbers, and that they are defined by several synonyms that may be used interchangeably e.g. 'division' can be expressed using several terms: 'divide', 'share', ' sort', 'distribute', 'split up' & 'allocate'. (Freospeech)
  - Repeated opportunities for vocabulary learning and practice is recommended
- Mathematical concepts
  - Therapists can help students "break down abstract / complex / unfamiliar concepts into manageable units via explicit teaching with multiple exposures" (Freospeech)

5

Summary of key themes from pre-readings

- Accommodations and Supports in mathematics
  - Direct intervention and teaching methods are not enough for students with DLD and/or dyscalculia.
  - Students with such challenges should have access to supports including: calculators (when indicated), extra time, grid paper, and highlighters to mark key words.
  - Therapists can advocate for changes to the learning environment to facilitate learning during mathematics

6

Outline

- Importance of being Numerate
- Dyscalculia and math difficulties
- Consideration when assessing
- Evidence based bath instruction
- Math and AAC
- Math and OT
- Math and Music Therapy
- Further learning

7

Importance of being Numerate

Things we need to know to be reasonably numerate in everyday life (Butterworth, 1999):

- **How to count**: both reciting the number words in the correct order and enumerating sets objects
- How to **read and write numerals** (to learn to translate from the name value system of English – 10, 10 x 10, and 10 x 10 x 10 are named by special words while the same symbols are used to represent them in place value numerals – 10, 100, 1000)
- **Number magnitudes** (ordering numbers by size)
- **Meanings of operation symbols** (+, -, x, ÷, =)
- Number facts (e.g. 8 + 7=15, 8 x 7=56)
- **Numerical procedures** (e.g. counting on to add, borrowing, carrying)
- **Principles, concepts and laws of arithmetic** (for example, that addition is commutative, but subtraction is not)

Think functional skills and participation!

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Dyscalculia and math difficulties

- Dyscalculia: Specific and persistent difficulty with **understanding arithmetic** and **basic number sense** (Hornigold, 2024)
- Mathematics difficulties: continuum with dyscalculia at the extreme end (most severe form of math difficulties)
- Key Indicators:
  - **Difficulties with subitising**
    - "Quickly recognising and quantifying small numbers of randomly organised dots" (Chinn, 2016)
  - **Numerical stroop**
    - "Knowing which digit symbol represents the bigger value number despite relative font sizes" (Chinn, 2016)

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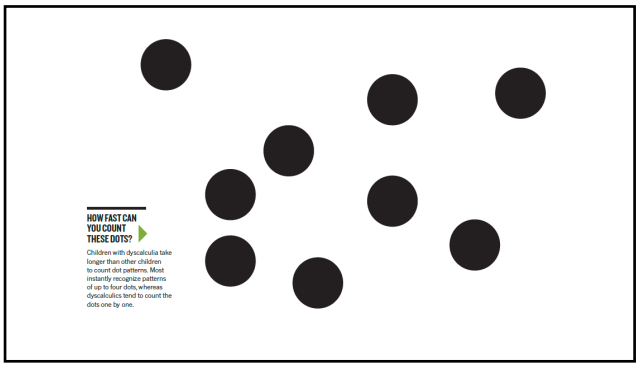

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Numerical Stroop

Which digit is **numerically** larger?

Congruent pair	Incongruent pair	Neutral pair – Numerical task	Neutral pair – Physical task
3 5	5 3	3 5	3 3

11

Dyscalculia continued…

- About 6% of the population have Dyscalculia
- This equates to 1 in 20 people
- Girls and boys are affected equally (Hornigold, 2015)
- Dyslexia ≠ Dyscalculia
  - Dycalculia CAN co-occur with dyslexia (as well as apraxia and ADHD)
- Diagnosis is usually made by a psychologist with further training and skills in this area (Chinn, 2016)
- Not everyone with dyscalculia will present the same way

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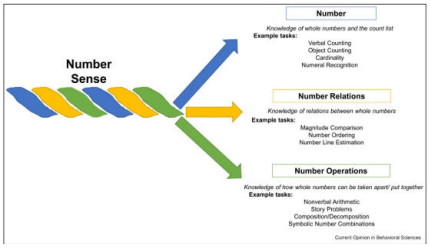
Number sense



Source: Current Opinion in Behavioral Sciences (2022)

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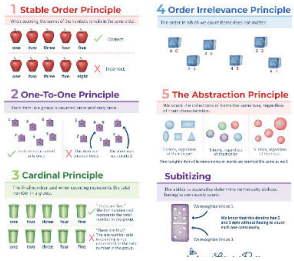
Principles of counting



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Assess before intervening

- When concerns have been raised/there are suspected concerns…
  - Review school reports
  - Obtain feedback from educator/s
  - Send out the Teacher Questionnaire on Maths in Cliniko
  - Look at examples of their in class math assignments/homework
  - Also look at results from your own language testing

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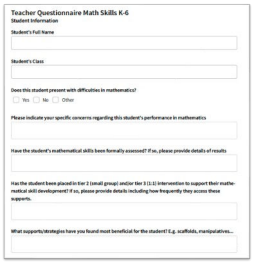
Teacher Questionnaire

- Available on Cliniko
- Send to educators when there are concerns regarding the student's mathematical skills


Teacher Questionnaire Math Skills K-6
Student Information
Student's Full Name
Student's Class
Does this student present with difficulties in mathematics?
Yes No Other
Please indicate your specific concerns regarding this student's performance in mathematics
Have the student's mathematical skills been formally assessed? If so, please provide details of results
Has the student been placed in tier 2 (small group) and/or tier 3 (1:1) intervention to support their mathematical skill development? If so, please provide details including how frequently they access these supports.
What supports/strategies have you found most beneficial for the student? E.g. scaffolds, manipulatives...

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Closer look at results from standard testing

- CELF-5
  - Following directions: information on knowledge of shapes, size concepts, positional concepts, quantities, and sequences
  - Word definitions: little
  - Semantic relationships: insight into knowledge of vocabulary also used in math, problem solving
- PPVT
  - Identify: ruler, arrow, group, sorting,
- EVT
  - Name: two, triangle, three, circle, four, five

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Timely and evidence-based math instruction

There are five instructional approaches to consider when supporting students with difficulty with mathematics (Powell et al., 2023). You can use some or all during intervention:

1. **Systematic and explicit instruction** (plan, model and practice)
2. Focus on the **language of math**
3. Use **multiple representations**
4. Build **fluency**
5. Provide **word problem instruction**

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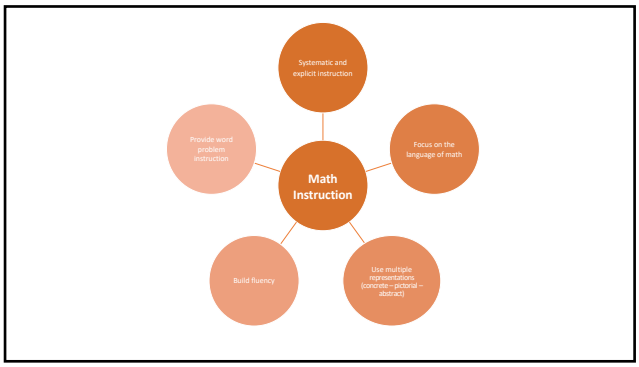

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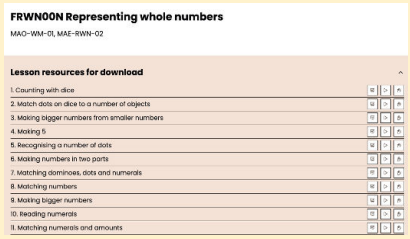
Explicit, systematic approaches

- OCHRE



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Delivering systematic instruction

MODELING	PRACTICE
Step-by-step explanation Planned examples	Guided practice Independent practice

SUPPORTS
Ask high- and low-level questions
Elicit frequent responses
Provide immediate affirmative and corrective feedback
Maintain a brisk pace

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Language and Mathematics

- Language and communication are vital in learning, understanding and applying mathematics" (Riccomini et al., 2015)
- In order to communicate using mathematical language, several elements must be present including:
  - Mathematical vocabulary
  - Numerical fluency
  - Comprehension skills

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Difficulties with Math Vocab Learning

1. Meanings of math terms being **context-dependent** (e.g. 'group' in math v social contexts)
2. Meanings having more **precise implications** (e.g. "product" being the solution to a problem in multiplication or something that a company produces)
3. Terms holding math specific meanings (e.g. polygon, parallelogram, imaginary number)
4. Terms having **multiple meanings** (e.g. side of a triangle vs. side of a cube)
5. **Technical meanings** specific to disciplines (e.g. "cone" suggesting the shape or food)
6. Everyday homonyms (e.g. pi vs pie)
7. Words that are related but different (e.g. circumference and perimeter)
8. challenges with translations (e.g. mesa vs table)
9. irregularities in the spelling of words (e.g. obeluses vs obeli)
10. different ways of expressing concepts (e.g. 15 minutes past or quarter past)
11. using informal terms rather than mathematical terms (e.g. diamond vs rhombus)

Rubenstein and Thompson (2002)

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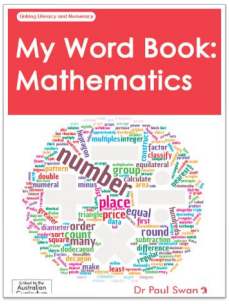
Language of math

- Identify vocabulary using Swan & Dunstan's My Word Book: Mathematics.



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Example

NUMBER & ALGEBRA ▶ NUMBER AND PLACE VALUE

Pre Primary		Year 1	Year 2
above / below	least	difference between	arrays
add, added, adding	left	digit	bridge ten
addition	less, less than	equal to	build to ten
altogether	make	estimate	column / row
answer	many	exchange	continue(s)
arrange	more, more than	extra	divide, by / into, division
as many as	most	first, second, third, ...	double, near double
before / after	nearly	forwards / backwards	equal groups of
beneath	next	group	exact, exactly
between	none	half way between	group in ...
big, bigger, biggest	not	join	hundreds (hundreds place)
classify	number	minus	
close, closer, closest	number track	number line, numeral	locate
collect, collections	one more / less	one's place	lots of
combine	one, ones	plus	multiply, multiplication,

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Language of math

- **Knowledge Rating Scale** (Swan)
  - 6 words at a time before teaching

Knowledge Rating Scale

Word				

Word	Have no idea	I have seen or heard it	I have a fairly good idea what it means	I can define it and explain what it means
quadrilateral				✓
square				✓
rectangle			✓	
rhombus		✓		
trapezium		✓		
kite		✓		

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Language of math

- Considerations to facilitate learning and retention:
  - A limited number of words should be used when introducing new vocabulary (**six or less**)
  - Vocabulary needs to be directly introduced
  - Child needs to LISTEN, SAY, WRITE and READ each word
  - Formulate their own definition
  - Teach word parts (morphemes) when possible
  - Ensure the newly introduced vocabulary is repeated regularly and often
  - Child needs to use the word in a variety of ways
    - Verbal: I think/know/believe/connect…
    - Non-verbal: drawings (e.g. arrays for number concepts), labelled diagrams, pictures

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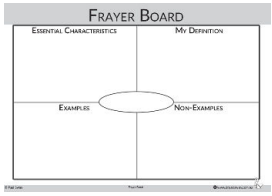
Graphic Organisers

- **Frayer model** can be used to learn new words and concepts in math
- Likens to the possm sheet we use for language therapy



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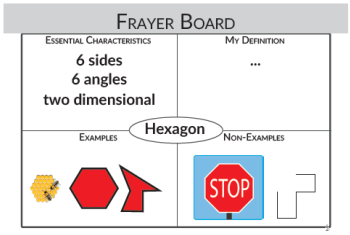
Example

- Beneficial when supporting children who have difficulty recalling names of shapes
- Student generates their own definition after filling in all other sections first.



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Multiple Representations

- Use **appropriate** and **effective** representations of mathematical concepts
- Also supports child to develop **visualisation skills**
- CPA approach
  - Explicit instructional sequence
  - Developed by Jerome Bruner in the 1960s
  - Progression through all three representations support comprehension in all learners
  - Representations can be:
    - **C**oncrete
    - **P**ictorial/semi-concrete
    - **A**bstract

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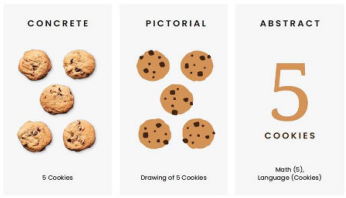
Concrete – Pictorial - Abstract

Learning occurs through…



Enactive means (doing, action based)

Iconic means (seeing, visual)

Symbolic means (abstract, codes, symbols)

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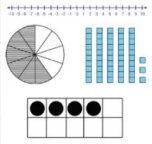
CPA in action

Concrete	Semi-Concrete Representational	Abstract
		$2y = 9 - 3x$ $\frac{5}{3}$ $138 + 59$

Source: Powell et al., 2024

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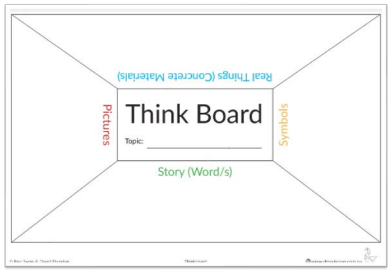
Think Board



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Think Board

- Haylock (1984)
- Board is divided into four sections.
- Each section is a different representation of the same mathematical idea.
  - **Stories:** words/vocabulary based on student experience.
  - **Real Things:** concrete materials or mathematics manipulatives.
  - **Pictures:** Drawings and diagrams (labelled drawing, might include numbers).
  - **Symbols:** (number sentence/ equation).
- Reinforces CPA approach

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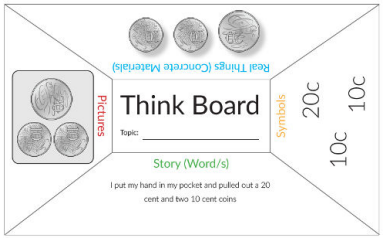
Think Board - example



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Fluency in Math

- "Fluency in math means doing math **easily** and **accurately**" (Powell et al., 2022) and 'the ability to **recall facts to the point of automaticity**' (Hatten-Roberts, 2023)
- Foundations for high level math skills
- Includes fluency in:
  - Counting
  - Operation: addition, subtractions, multiplication, division
  - Identifying benchmark fractions
  - Applying formulas in geometry
- Effective instruction requires:
  - modelling
  - multiple opportunities to practice
  - immediate feedback
  - appropriate ratio of known to unknown number combinations

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Fluency

- The addition and subtraction facts of at least to 10 should be taught to automaticity from Year 1
- Multiplication should be covered after in Year 2 and 3, and division from there.
- Also need to develop fluency in recalling:
  - declarative facts, such as measurement conversion, 1000 ml = 1 L
  - attributes of angles
  - definition of a fraction (showing a visual) with its parts
  - numerator and denominator
  - maths specific academic language
- **Note:** addition and subtraction should be taught together, and multiplication and division together.
- Develop fluency with SPACED RETRIEVAL

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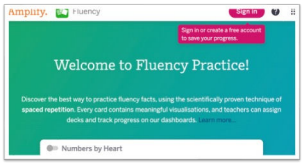
Fluency resources

- Develop fluency facts: https://fluency.amplify.com/
  - Uses 'spaced repetition' (can be done daily)
  - Includes Subitising, and Addition, Subtraction, Multiplication and Division "by heart"



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Word problems/problem solving

- Word problems can be challenging as the student is required to:
  - Read and understand the problem
  - Understand the mathematics vocabulary in the problem
  - Identify and separate relevant information from irrelevant information
  - Represent the problem correctly
  - Choose an appropriate strategy for solving the problem
  - Perform the computational procedures
  - Check the answer to ensure that it makes sense
- Any difficulty at one of these levels can contribute to an incorrect answer.

(Adapted from Stevens and Powell, 2016; Jitendra, et al., 2015; Jitendra et al., 2013)

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Support for word problems

- Two key supports:
  - Provide **schema instruction**, AND
  - An **attack strategy** (Lein et al., 2020).
- Schema Instruction:
  - Explicit instruction including:
    - Identifying the schema (type of word problem/underlying structure of the word problem)
    - Representing the schema correctly
    - Understand how to set up an equation for each schema

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Word Problems and Schemas

- Word problems can be categorised as **additive schemas** or **multiplicative schemas** (Powell & Fuchs (2018)).

Additive Schemas	Multiplicative Schemas

- Used for addition and subtraction problems
- Typically taught first
- Include the following examples:
  - Total
  - Difference
  - Change
	- Used for multiplication and division problems
	- Include the following examples:
	  - Equal Groups
	  - Comparison
	  - Ratios/Proportions

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Word Problems and Attack Strategy

- Step-by-step process for working through a word problem, and this attack strategy can be used to solve all different types of word problems (Fuchs et al., 2019; Jitendra & Star, 2012).
- Different kinds of attack strategies
- Examples: **RUN strategy**

Figure 5 Word-problem example with attack strategy and schema focus

Daniel bought 45 bagels and ~~2 cartons of orange juice~~ for his family party. Some of the bagels were plain, 18 were everything bagels, and 13 were cinnamon raisin bagels. How many plain bagels did Daniel buy?

Read ☑
Underline label and cross off irrelevent information ☑
Name problem type ☑

Total
P1 + P2 + P3 = T
__ + 18 + 13 = 45
__ + 31 = 45
45 - 31 = __

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Math and AAC

- Model numbers on the student's device whilst saying verbally
- Help reinforce CPA approach to learning
- Can be done across all areas of learning
- Supports child's ability to subitise
- Also encourage child to use their 'voice' (device) when engaging in counting tasks

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Math and LAMP WFL

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OT and Mathematics

- "**Fine motor skills** are closely related to **early numerical skill development** through finger-based numerical counting that aids the acquisition of mathematical mental representations." (Fischer, Stoeger and Suggate, 2017).
- Strong FMS are needed to use manipulatives in mathematics correctly and efficiently
- "A child who is strong in fine motor skills but weaker in math concepts can use manipulatives to build on math skills.
- A child who lags behind in fine motor dexterity and manipulation skills can utilize math skills to build strength in fine motor."

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OT and Mathematics

- OT's with further training and/or supervision in this area can:
  - Assess strengths and challenges and set goals
  - Support fine motor skill development e.g. through using math manipulatives
  - Address visual perception and spatial reasoning skills (Important for understanding math concepts)
  - Support attention and concentration (important for learning and performing mathematical tasks)
  - Teach organisational and planning skills (particularly important for solving mathematical problems)
  - Assess and indivisualise tools and technology (e.g modified calculators)
  - Teach multisensory techniques to facilitate knowledge of math concepts
  - Collaborate and train parents, teachers and other professionals

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Intervention Ideas

Tools and Technology
Hand held calculator (simpler and more durable buttons, portable)

Touch Math
Strengthen counting skills using kinaesthetic awareness

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Music Therapy and Mathematics

- Counting songs can engage and motivate clients while developing their cardinality skills (Platas, 2017).
- "Children's rhymes, games, and songs have set the stage for the seemingly effortless acquisition of verbal counting" (Platas, 2017).
- Music technology enhances the rate of assignment completion and contributes to improved motivation (Bahr, Nelson, and VanMeter, 1996).
- Music therapy can be beneficial in teaching concepts to children who are otherwise disengaged/disinterested in traditional therapy (Chukwudi et al., 2019)

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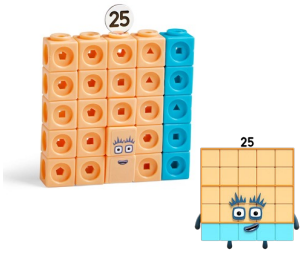
A word on Numberblocks

- Developed in the UK by BBC Studios and the National Centre for Excellence in the Teaching of Mathematics
- In Judy Hornigold's own words "Numberblocks are great- devised by experts in the field!"
- Often recommending tio preschool parents and EL centres
- Fantastic means of teaching children many principles associated with counting
- Songs also available for times tables



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Adult Lifelong Disability and Mathematics

Functional Application of Mathematical Knowledge and Skills

- Managing money
- Shopping
- Preparing and cooking food
- Clocking in at work (time)
- Figuring out distance, time and cost for travel
- Understanding bills
- Understanding sports

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10 Tips to share with Parents & Educators

1. Use concrete materials, such as Cuisenaire rods or base ten materials
2. Spend time exploring these and don't take them away too soon, they will help to develop the child's understanding.
3. Play games with dice and dominoes so that the child can recognise common dot patterns.
4. Try to encourage the child to use more efficient calculating strategies, such as counting on rather than counting all.
5. Encourage the child to visualise the maths- by drawing diagrams and using concrete materials to model the maths.
6. Make the maths practical and multisensory- avoid worksheets.
7. Spend time on place value so that it is fully understood, this can be a very difficult concept to grasp.
8. Have a little and often approach- repetition and 'overlearning' will help.
9. Use mathematical language as much as possible and encourage the child to do the same.
10. Give multiplication grids and number bonds to reduce the stress of having to remember these facts.

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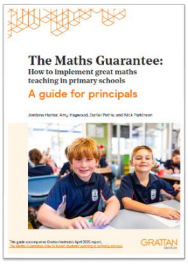
Advocacy: Get Principals in the know

- Guide released May 2025 by the Grattan Institute
- In response to ongoing underperformance of primary school aged children in Australian schools
- Reiterates importance of **explicit, systematic teaching methods** from K-6
- Schools in the review have demonstrated successful use (and adapting) of OCHRE's free math materials



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Learn more from

- Sarah Powell https://x.com/sarahpowellphd
- Steve Chin
- Judy Hornigold
- Multisensory Math 1 with Marilyn Zecher
- Designing effective intervention in mathematics with Dr Sarah Powell
- Multisensory program Maths u See.

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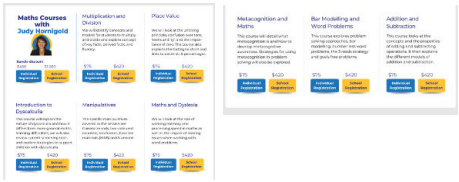
Further learning/training

- Judy Hornigold has eight, self-paced math courses available through SPELD NSW
- UK based Educational consultant in the area of Dyslexia and Dyscalculia



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