VISUAL STRENGTHS IN SPLD: MIND-MAPPING FOR DYSCALCULIA

- Visualisation: What are we looking at?
- Mind-mapping as a Teaching Tool – Graphic Organisers
- Mind-mapping as an aid for revision and understanding – Concept and process maps
- Mind-mapping for ideas and organisation
CHALLENGE: Using pen and paper...

• Communicate exponential growth
  – How many of these...?

• Communicate the difference between radius, diameter and circumference.
  – How many of these...?
The Paradox in the Paradigms

Visual Intelligence
- Everybody has it (Gardner, 1974)
- Much research and anecdotal evidence to suggest it is a relative strength in SpLDs (e.g. Bacon and Bennet, 2015)
- Visual ability and strategy integral to maths (e.g. Giaquinto, 2007)

Triple Code Model (Dyscalculia)
- Visual code, analogical magnitude code and verbal code (Dehaene, 1992)
- Many more studies identify issues in visuo-spatial ability (e.g. Szuchs et al, 2013)

(Also consider magnocellular deficit theory in dyslexia?)
In my humble opinion...

The parietal lobe is around about here and contains the IPS and is generally agreed to be the main area involved in visual-spatial working memory.

Dyscalculia is believed to be centred around about here – in the IPS (Intraparietal Sulcus)...

...and here, in the angular gyrus

The occipital lobe is approximately here, and contains the primary visual cortex

Clear links between the affected areas...
In my humble opinion...

Magnitude representation is believed to reside within the IPS

Other areas of number processing (Triple Code Model) are the ‘verbal’, believed to reside around here....

... and the ‘visual’, believed to be about here.
In my humble opinion...

The dorsal stream is responsible for “knowing where” and follows the yellow route.

The ventral stream is responsible for “knowing what” and follows the blue route.
So...

VISUAL
- “Knowing What”
- Ventral Stream
- Long Term Memory and Retrieval
- Rare feature of dyscalculia (Faramarzi & Sadri, 2014)

SPATIAL
- “Knowing Where”
- Dorsal Stream
- Working Memory and Processing
- A dominant feature of Dyscalculia (Szucs et al, 2013)

Utililise the strength to develop the relative weakness?
Benefits of Visual Techniques

• Astrid Brinkmann on mind-mapping as a collaborative student activity:
  – Group work allows for discussion
  – Provides a visual structure – visual memory is generally a strength
  – Part of an over-learning strategy, avoiding pure repetition
  – Allows tutors to identify errors in perceived connections between concepts
  – Visually connect new information with previously learned information
  – Can be combined

• Geoff Petty on why visual representations work:
  – Most teaching is linguistic and sequential (left-brain); incorporating holistic and visual (right-brain) techniques creates ‘whole-brain’ learning
  – Recall is often triggered visually
  – The structured nature of visual representations aids the organisation of information in LTM
  – It could be assumed that visual thought is close to the brain’s natural ‘language’ (mentalese)
PART 2: WORKSHOP
Mind-mapping can be use for...

- A student activity
- Learning game
- A thinking tool
- A way to make notes
- A summary
- A means to plan
- An advance organiser
- A display of information
- A source for questions and activities
Mind-maps for teaching: Graphic Organisers

• Using the ventral and dorsal streams
  – Ventral can (in the majority of cases) be considered to be functioning ‘normally’
  – Dorsal can be strengthened with training and over-learning (for example; Faramarzi and Sadri, 2014)

• Strong Evidence Base
  – No.1 strategy for positive effects on learning outcomes (effect size 1.3 (Petty, 2006))
  – Supports over-learning:
    – “Tell them what you’re going to tell them, then tell them, then tell them that you’ve told them” (Aristotle, c.400BC)
Mind-maps for revision: Concept and Process maps

• Using the ventral stream; retrieving information from long term memory
• Self-explanation to improve understanding and form of peer tutoring
  – Supports reciprocal teaching and feedback (effect sizes 0.86 and 0.81 respectively; Hattie, 2009) when used co-operatively (effect size 0.78; Marzano, 2001)
• Multi-modal (notes, pictures, mnemonics, diagrams etc.) supports memory: retention and retrieval
• Creative!!
Mind-maps for organising ideas and decision making

- For example
  - Which statistical test to use in a piece of research
  - Prioritising activities

Image taken from: (https://atouchofkoan.files.wordpress.com/2014/04/math_decisions.png)
Try your own...

• Here are some ideas to whet your appetite...
SOLVING A QUADRATIC EQUATION

The Discriminant
"Nature of the Roots"
- \( d = 0 \) (1 real root)
- \( d < 0 \) (2 imaginary roots)
- \( d > 0 \) (2 real roots)

Taking the Roots
- \( x^2 = 36 \)
- \( \sqrt{x^2} = \sqrt{36} \)
- \( x = \pm 6 \)

Quadratic Formula
- \( x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \)

Factoring
- \( 6x^2 + x - 4 = 0 \)
- \( 16x^2 - 81 = 0 \)
- \( (2x-1)(3x+4) = 0 \)
- \( (4x-9)(4x+9) = 0 \)
- \( x = \frac{1}{2}, \ x = -\frac{4}{3} \)
- \( x = \pm \frac{9}{4} \)

Completing the Square
- \( x^2 - 10x + 3 = 0 \)
- \( x^2 - 10x = -3 \)
- \( x^2 - 10x + 25 = -3 + 25 \)
- \( (x-5)^2 = 22 \)
- \( \sqrt{(x-5)^2} = \sqrt{22} \)
- \( x-5 = \pm \sqrt{22} \)
- \( x = 5 \pm \sqrt{22} \)

Remember! No matter the method chosen, it all connects back to Roots, Solutions, Zeros, + X-intercepts.

Graphing
- No real roots
- 1 real root
- 2 imaginary roots
- 2 real roots

Tables
- \( x \rightarrow y \)
A BASE is the number of digits used in a numerical system.

Different bases have different uses across different disciplines.

BASES

- BASE 10
  - Decimal
  - MOST COMMON

- BASE 2
  - Binary

- BASE 60
  - Sexagesimal
  - Geometry: Angles (60°, 120°, 240°, 360°)
  - Time: Hours, Minutes, Seconds

Computing
  - Musical notation

Egyptian Multiplication
EXAMPLE
ROLLING DICE
Calculate the average of an increasing number of rolls of die. Rolling one dice 500 times would result in a "flat" distribution. As the number of dice used increases, the averages obtained near N.D.

WHAT?
VERY IMPORTANT!
"The mean of the measurements of a sufficiently large (\(\infty\)) number of random variables will be normally distributed"

WHO?
Alan Turing in 1934... until he found out that Lindeburg had already proved the theory in 1922!

CENTRAL LIMIT THEOREM

VARIATIONS; e.g.
Lyapunov - random variables \(x_i\) must be independent, but not necessarily symmetrically distributed.

CONSEQUENCES
Skewed distributions of random variables found in experiments will eventually adapt to a normal distribution as \(n\) approaches \(\infty\).
Get active....

• In small groups, discuss some topics that you and/or your learners tend to struggle with.
  – How can the topic be visualised?
  – Are you concerned about input? Or accurate understanding and note-taking? Revision...?
  – How can the information be organised?
• Produce at least one graphic organiser/mind-map/chart for your chosen topic(s)
• Choose a speaker to present your creation to the rest of the group!
References and Acknowledgements

- Dehaene, S 1992, 'Varieties of numerical abilities', *Cognition*, 44, 1-2, pp. 1-42,
- Faramarzi, S, & Sadri, S 2014, 'The effect of basic neuropsychological interventions on performance of students with dyscalculia', *Neuropsychiatry & Neuropsychology / Neuropsychiatria I Neuropsychologia*, 9, 2, pp. 48-54