THE UNIVERSITY OF SYDNEY
Sydney School of Education & Social Work

Embodied Learning in Early Mathematics & Science
(ELEMS)

NSW GOVERNMENT Education
Strategic Research Fund
In collaboration with *NSW Maths Strategy Professional Learning*

Maths actions

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1. Using our hands
2. Using body positioning and movement
3. Supporting drawing development

What embodied modes do you already use?

What else could you be doing?

Canberra Mathematics Association Conference, March 2024

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Workshop focus

Research in the fields of neuroscience, psychology and education provides strong evidence for the learning benefits of utilising the natural human tendency to engage the whole body in interactions with the immediate environment - not just ears, eyes and brain.

The *Embodied Learning in Early Mathematics and Science* (ELEMS) project has been working with teachers for two years to explore learning opportunities afforded by gesture, conceptual body movement, touch and drawing.

In this session you will be supported to reflect on the embodied learning approaches you already use in your teaching and consider new ways to take advantage of 'doing what comes naturally'.

2

Use your fingers to count to 10

Did you...

- Have palms or back of hands facing?
- Start with right or left hand?
- Start with closed fist or open hand?
- Hold your hands vertically, horizontally, other?
- Start to count with your thumb, pointer, little finger, other?
- Use the same order of fingers on your second hand?

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Using fingers to count comes naturally, worldwide, But counting methods vary

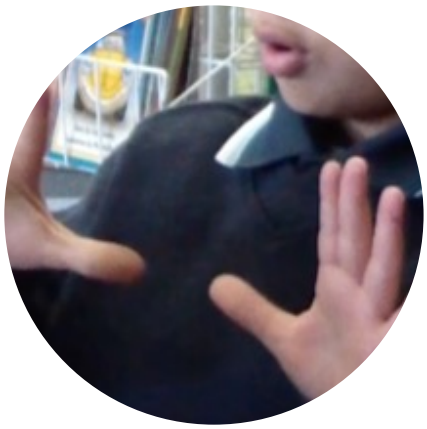
Europeans tend to begin with a closed fist and raise fingers beginning with the thumb

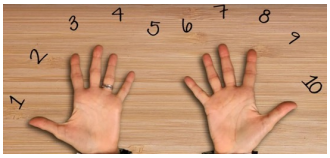
Middle East are likely to begin with the little finger

Japanese are likely to begin with an open hand and start by lowering the little finger

Chinese and North American people often start the count with the pointing (index) finger

(Bender,& Beller, 2012)





Note: Continuous left to right has advantages

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From the research...

- Neuropsychological evidence on the importance of 'finger sense' (finger gnosis) and fine-motor skills (finger movement) in early number development
(Barrocas et al., 2020)
- Overlapping neural pathways in the brain that are activated when thinking about our own fingers and thinking about numbers
(Chinello et al., 2013; Penner-Wilger & Anderson, 2013).
- Training 5/6-year-olds to use their fingers to represent numbers and for finger counting, improves their mathematical problem-solving abilities
(Gracia-Bafalluy & Noël, 2008; Ollivier et al., 2020)

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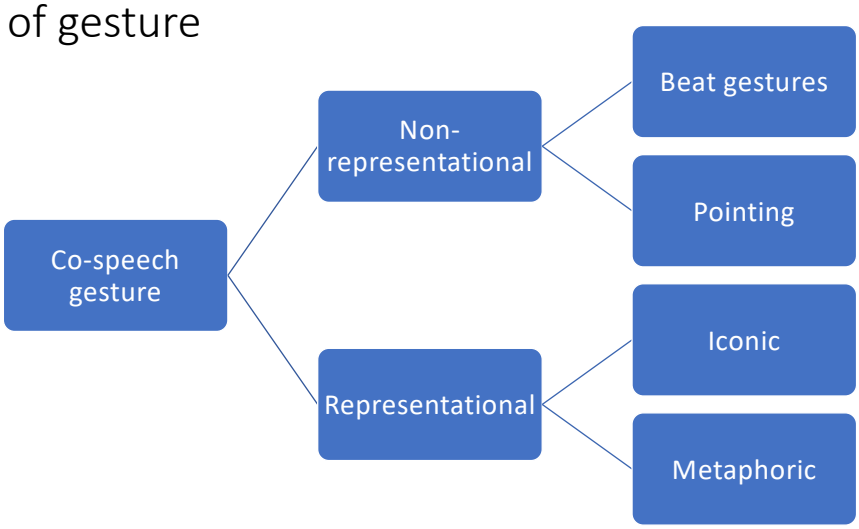
Types of gesture



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Are the gestures you use while teaching spontaneous or do you have some deliberately planned gestures you use regularly?

In the ELEMS Project (Phase 1, 2022) the teachers found ICONIC gesture to be most effective.

That is, a gesture representing a concept

Do you have gestures for:

- Count forwards/back
- Number before/after
- Repeating pattern
- Triangle, rectangle
- Tall, short, wide
- Under, over, beside, around
- ????

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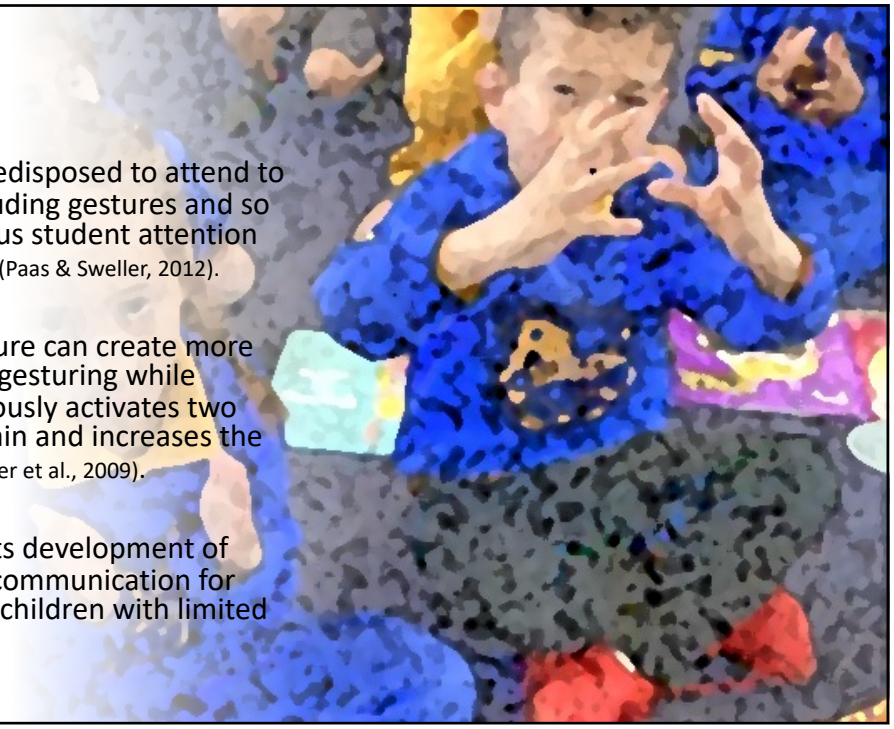
GESTURE

From the research:

Humans are genetically predisposed to attend to nonverbal behaviours including gestures and so gesture can be used to focus student attention and enhance engagement (Paas & Sweller, 2012).

Children's own use of gesture can create more robust memories because gesturing while communicating simultaneously activates two different regions of the brain and increases the likelihood of retrieval (Skipper et al., 2009).

The use of gesture supports development of vocabulary and opens-up communication for reluctant speakers and for children with limited English language skills.



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Thinking with your hands …..

1. Take turns to feel the object inside the bag **without looking**.
2. Discuss your ideas about the structure of the object?
3. Can you reach consensus?
4. You have the option of feeling inside the bag once more.

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Activating 'touch memory'

"Students were practising number formation, first tracing the number then closing their eyes to draw it on their friend's back."

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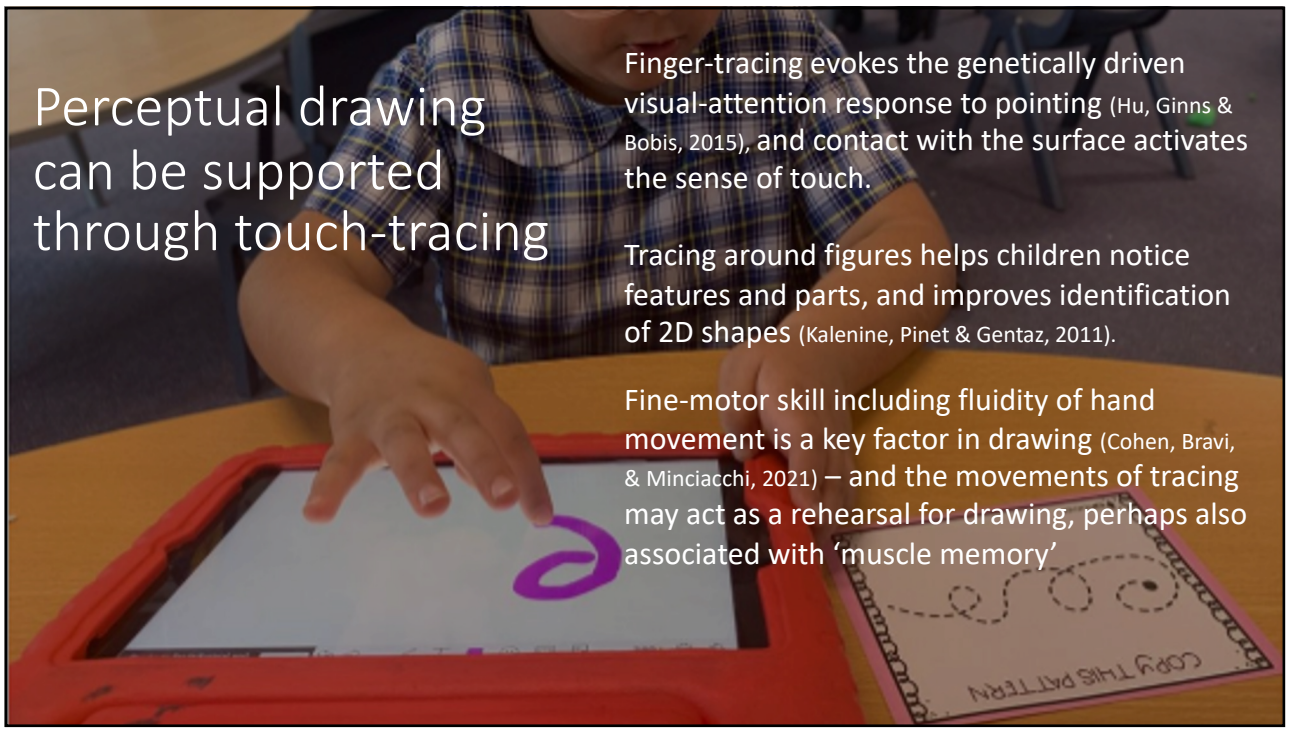

Perceptual drawing can be supported through touch-tracing

Finger-tracing evokes the genetically driven visual-attention response to pointing (Hu, Ginns & Bobis, 2015), and contact with the surface activates the sense of touch.

Tracing around figures helps children notice features and parts, and improves identification of 2D shapes (Kalenine, Pinet & Gentaz, 2011).

Fine-motor skill including fluidity of hand movement is a key factor in drawing (Cohen, Bravi, & Minciacchi, 2021) – and the movements of tracing may act as a rehearsal for drawing, perhaps also associated with 'muscle memory'

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Making connections

*"I was getting them to trace or draw 2D shapes on the floor and **draw in the air***

They made that connection when they were actually physically using their finger to draw and trace. You could see their understanding improve from doing that.

Rather than just looking at something on the whiteboard, it's definitely something that connects the brain with their hands and their body movements" (Yr 1 Teacher 2022)

Air-tracing 2D shapes

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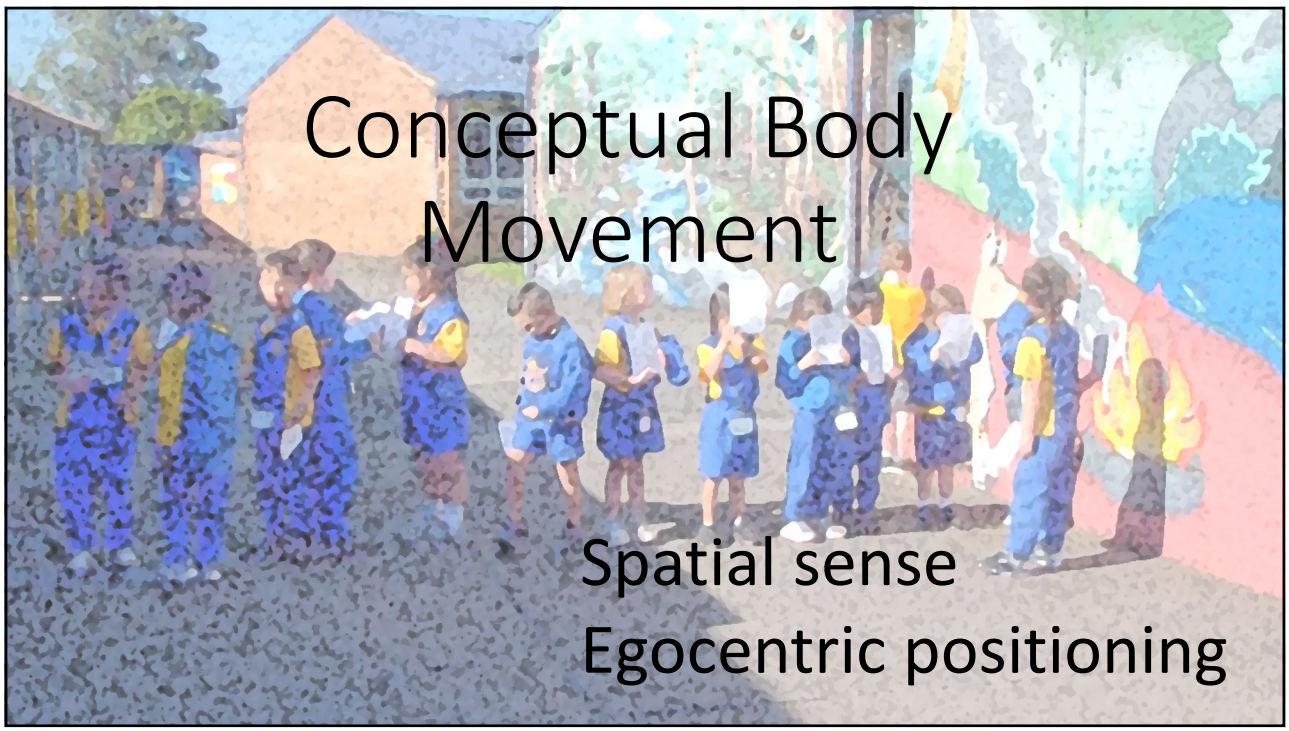
Conceptual Body Movement
Spatial sense
Egocentric positioning

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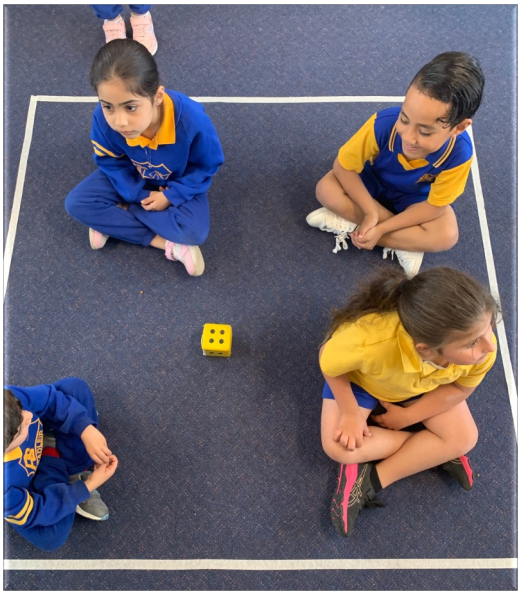
Be a dot



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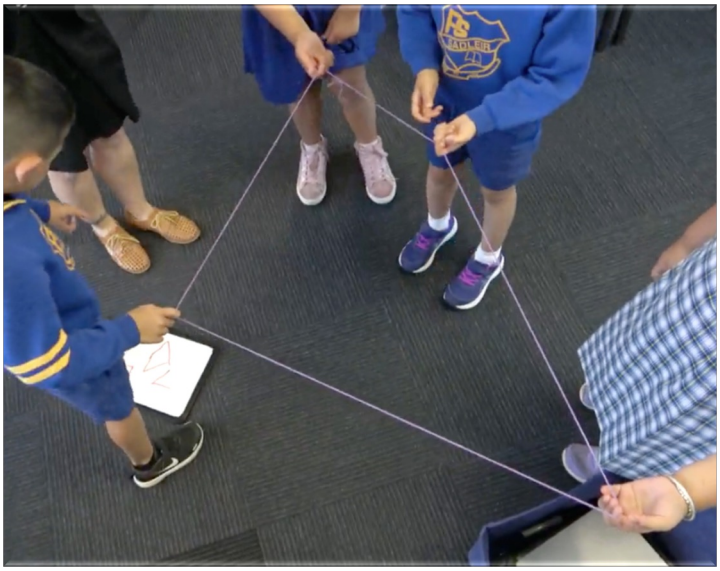
Be a corner



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Walk a number

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Benefits of body movement

Connecting **spatial thinking** with number concepts such as magnitude, number line estimation and equal spacings strengthens number knowledge and number sense.

An **egocentric frame** of reference means positioning yourself in relation to other objects.

An allocentric frame of reference means considering the position of external objects in relation to other external objects.

Switching between ego- and allo- centric perspectives seems to stimulate powerful learning.
(Dackermann, Fischer, Nuerk, Cress & Moeller, 2017)

An eye-level perspective combined with an imagined view-from-above is needed

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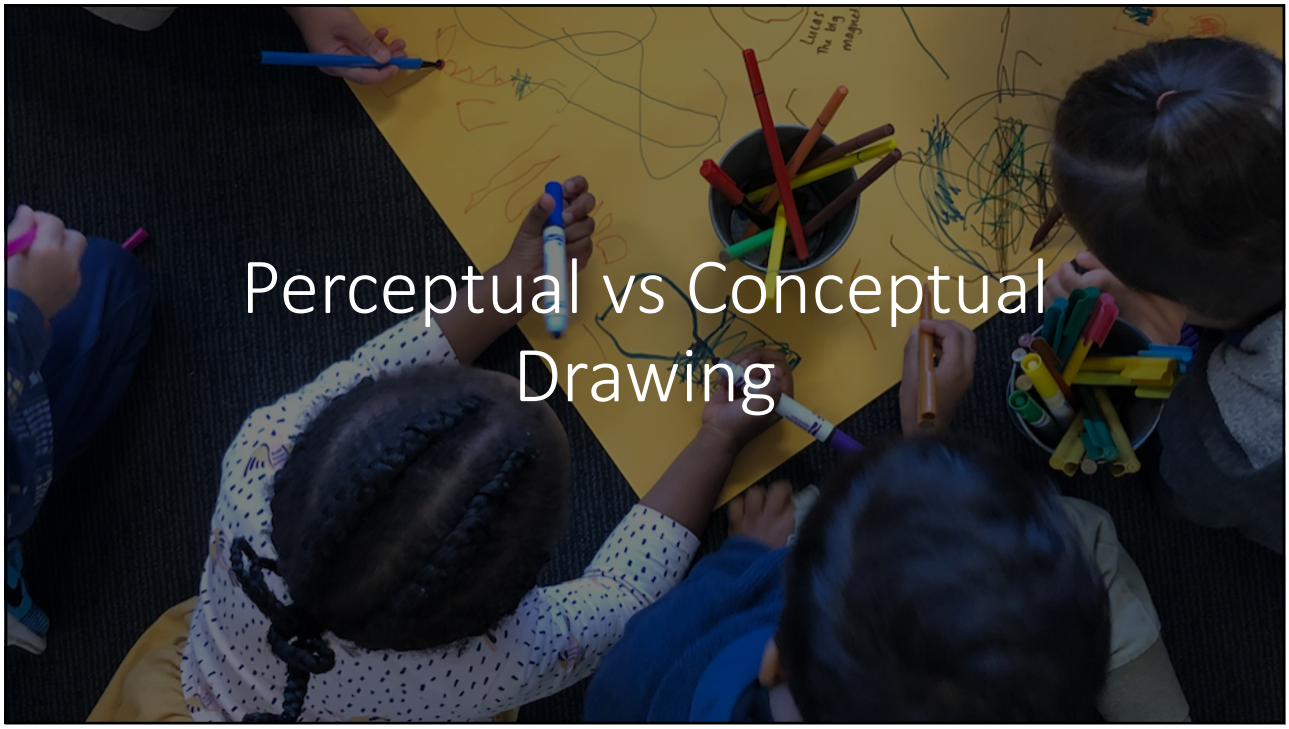

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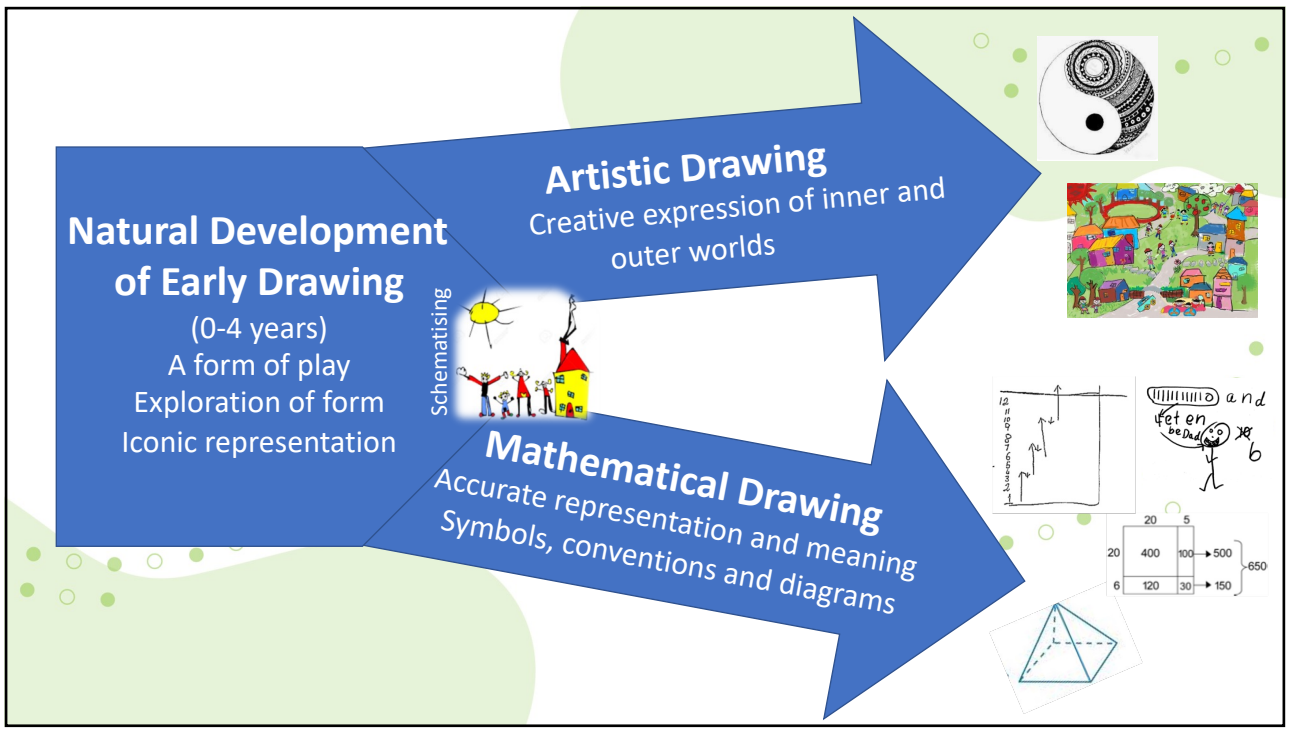

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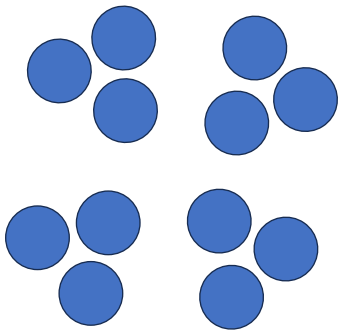
Draw what you saw



Perceptual Drawing

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Draw something tall and something short

Conceptual Drawing

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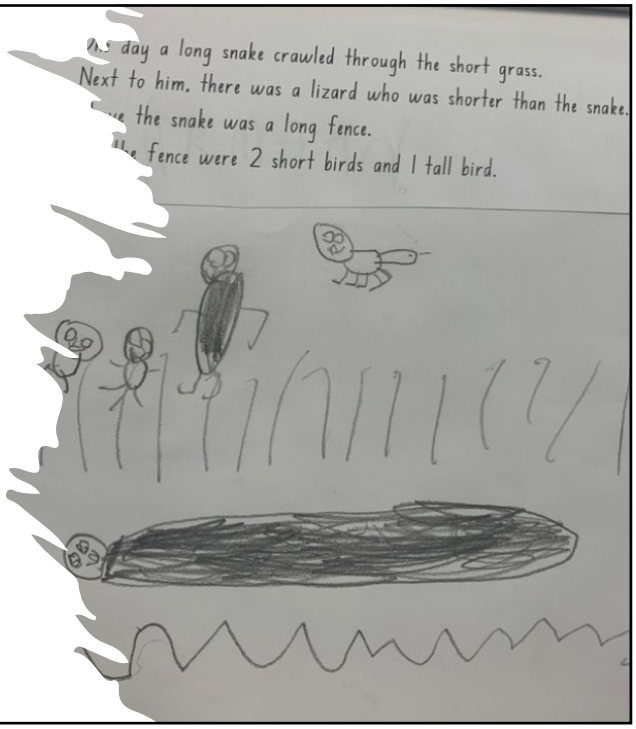
Conceptual drawing

Is more difficult .....

- Requires deciding what to draw
- Knowing how to draw it
- Must be based on a previous experience and memory
- Inventing new ways drawing if no schema already exists



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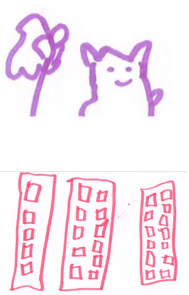
Tall & short – Preschool to Year 2

A. Incoherent (Scribble)

B. One Object

C. Similar Size



D. No baseline

E. Baseline

(Way, 2023)

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Distribution across Year levels 109 children

Drawing Category	Pre-school	Kinder	Year 1	Year 2	Total for category	Percentage n=109
A: Incoherent	7	8	6	0	21	19.3%
B: One Object	1	4	2	1	8	7.3%
C: Similar Size	1	3	1	2	7	6.4%
D: No Baseline	1	12	18	10	41	37.6%
E: Baseline	0	5	9	18	32	29.4%

- The more sophisticated depictions of tall and short were more prevalent in Year 1 and 2 than in Preschool and Kindergarten.
- 67% of the children created a drawing of recognisable objects and made an obvious distinction between their heights.
- Of note is the persistence of incoherent drawings into Year 1.

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