Specialist Knowledge for Teaching Mathematics (SKTM)
Primary Programme

Network Collaborative Project
Subject Knowledge for Teaching Mathematics

Spatial Reasoning: East Midlands South Taster session

MATHSHUBS
EAST MIDLANDS SOUTH

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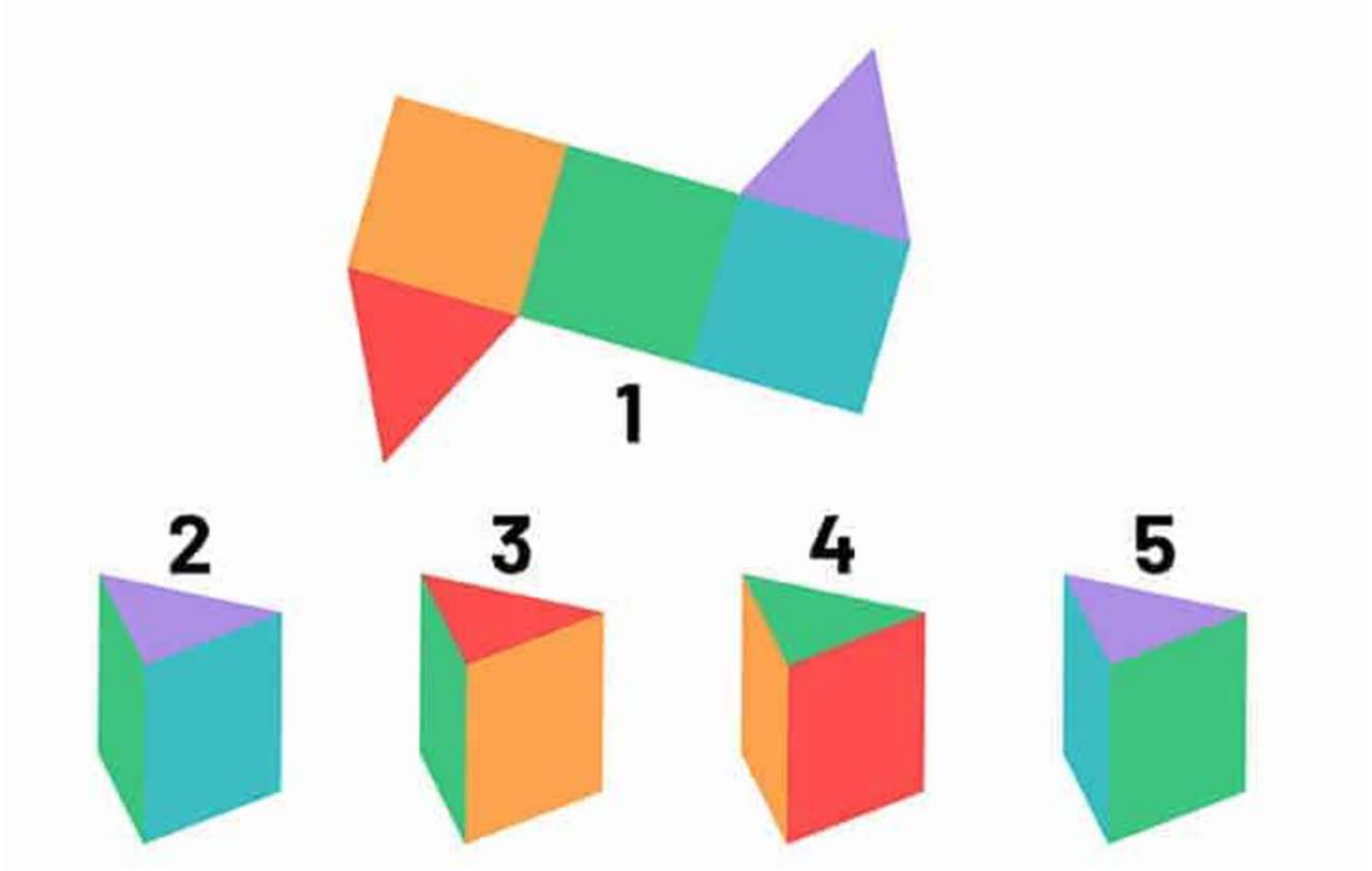
MATHSHUBS



Today we will:

- introduce the format of the SKTM programmes
- discuss why a focus on spatial reasoning may be important for your school
- introduce some of the key elements of spatial reasoning

Subject Knowledge for Teaching Mathematics

SKTM EARLY YEARS TEACHERS PROGRAMME

PATTERN, SHAPE, SPACE AND MEASURES PATHWAY

https://www.emsmathshub.org.uk/professional-development/pd-2023-24/early-years-sktm-pattern-shape-space-and-measures/

SKTM PRIMARY TEACHERS PROGRAMME

SPATIAL REASONING PATHWAY

https://www.emsmathshub.org.uk/professional-development/pd-2023-24/specialist-knowledge-for-teaching-maths-primary-teachers-spatial-reasoning-pathway/

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Subject Knowledge for Teaching Mathematics

SKTM EARLY YEARS TEACHERS PROGRAMME

- Teachers and Teaching Assistants working in EYFS
- Subject Leads wanting to learn more about mathematics in EYFS
- Teachers working in SEND settings.

SKTM PRIMARY TEACHERS PROGRAMME

- Teachers from Y1-Y6
- Subject Leads wanting to develop spatial reasoning across the school
- Teachers wanting to widen their knowledge beyond number

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02 Primary Teachers
SKTM – Spatial
Reasoning Pathway

Mathshubs Annual Report

Vicki Giffard
Maths consultant and former maths lead, LLME for East Midlands South Maths Hub

The Primary Teachers SKTM Programme has two pathways – Number and Spatial Reasoning – and is designed for primary teachers who want to improve their subject and pedagogical knowledge. It provides professional learning in workshop sessions, alongside focused practice development in the classroom. This year, Vicki Giffard, maths consultant and former maths lead, led the Spatial Reasoning pathway for East Midlands South Maths Hub, after previously running a Research and Innovation Work Group (RIWG) on the topic.

Research is an important part of any SKTM programme, as it helps participants see the rationale behind the pedagogy. Vicki's passion for and experience in maths research enhanced her leadership of this programme, and enabled her to tailor the content for her group. A key focus for the Work Group soon became 'how precise language and gesture can be used to support spatial thinking and reasoning'.

The programme really opened my eyes to the importance of teaching shape and space to children, alongside the continued focus on number. It was wonderful to see one particular pupil grow in confidence and capability through working with her on her spatial reasoning and visualisation skills.

Kate Burrows, Year 4 teacher at Stafford Leys Primary School, Leicester

I feel more confident to focus on the children's needs, such as using manipulatives more suitable for the children, rather than having to use the one on the lesson plan.

Primary Early Career Teacher

Participants explored visualisation techniques and how early experiences, such as playing with construction toys and puzzles, are crucial for spatial reasoning development in young children. Activities including tangrams and block play, and reinforcing spatial language during PE sessions, were incorporated into the curriculum. Teachers reported improvements in their pupils' confidence and proficiency in reasoning skills, and this holistic approach supported their understanding of more difficult concepts.

Using NCETM centrally produced materials to support them, participants designed tasks to improve spatial reasoning, which helped them notice how spatial reasoning underpins other areas of maths, and the importance of developing this. Teachers found that paying greater attention to variation benefitted the children's mathematical language, and they were able to define shapes more precisely using accurate vocabulary.

Why make space for spatial reasoning?

Spatial reasoning is important in our daily lives

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Children have very differing experiences

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Spatial reasoning is malleable

Spatial reasoning skills can be improved through:

- exposure to spatial language
- hands-on activities
- visualisation, including use of gesture
- use of technology

Training is durable and transferable.

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Spatial reasoning is important for STEM careers

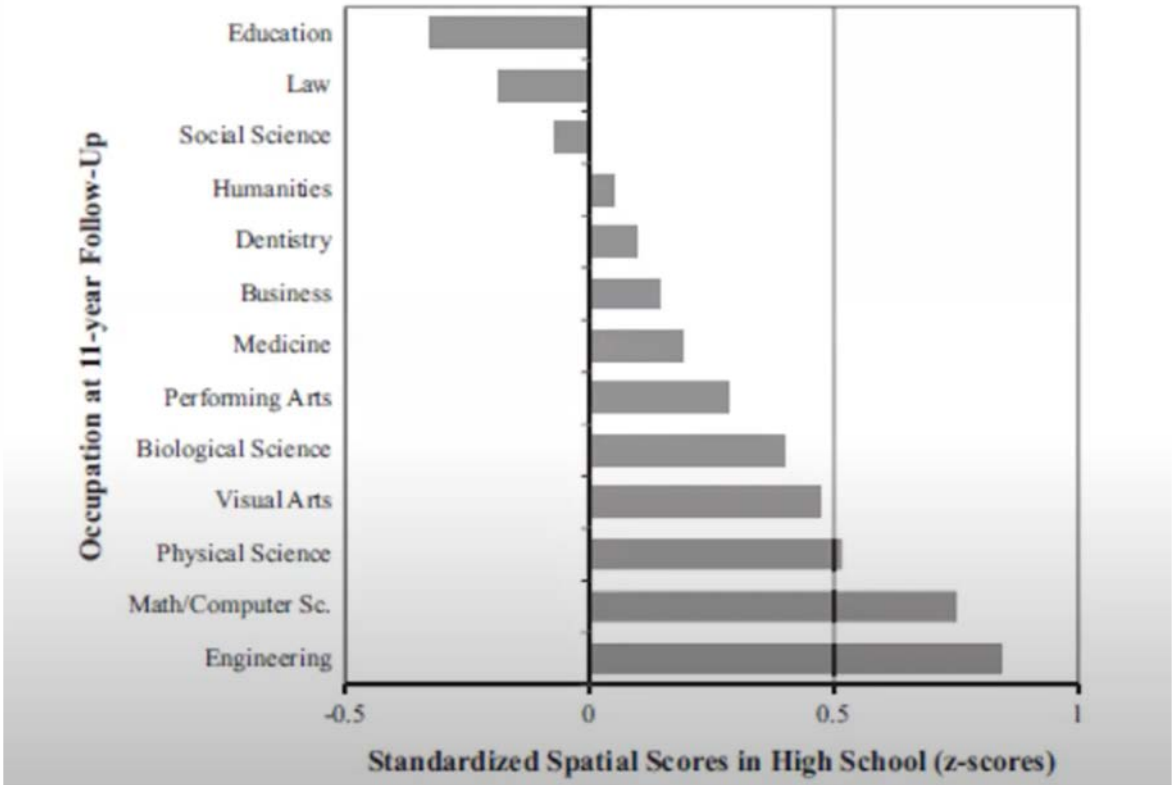

Fig. 1. Spatial Scores in 9th–12th Grade and Reported Occupations 11 Years Later.

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Engineers visualise how forces affect the design of a structure

Neurosurgeons use MRI to visualise the brain and determine the outcome of surgery

Biologists represent processes through illustration (DNA replication)

Geologists use timelines to understand geologic time

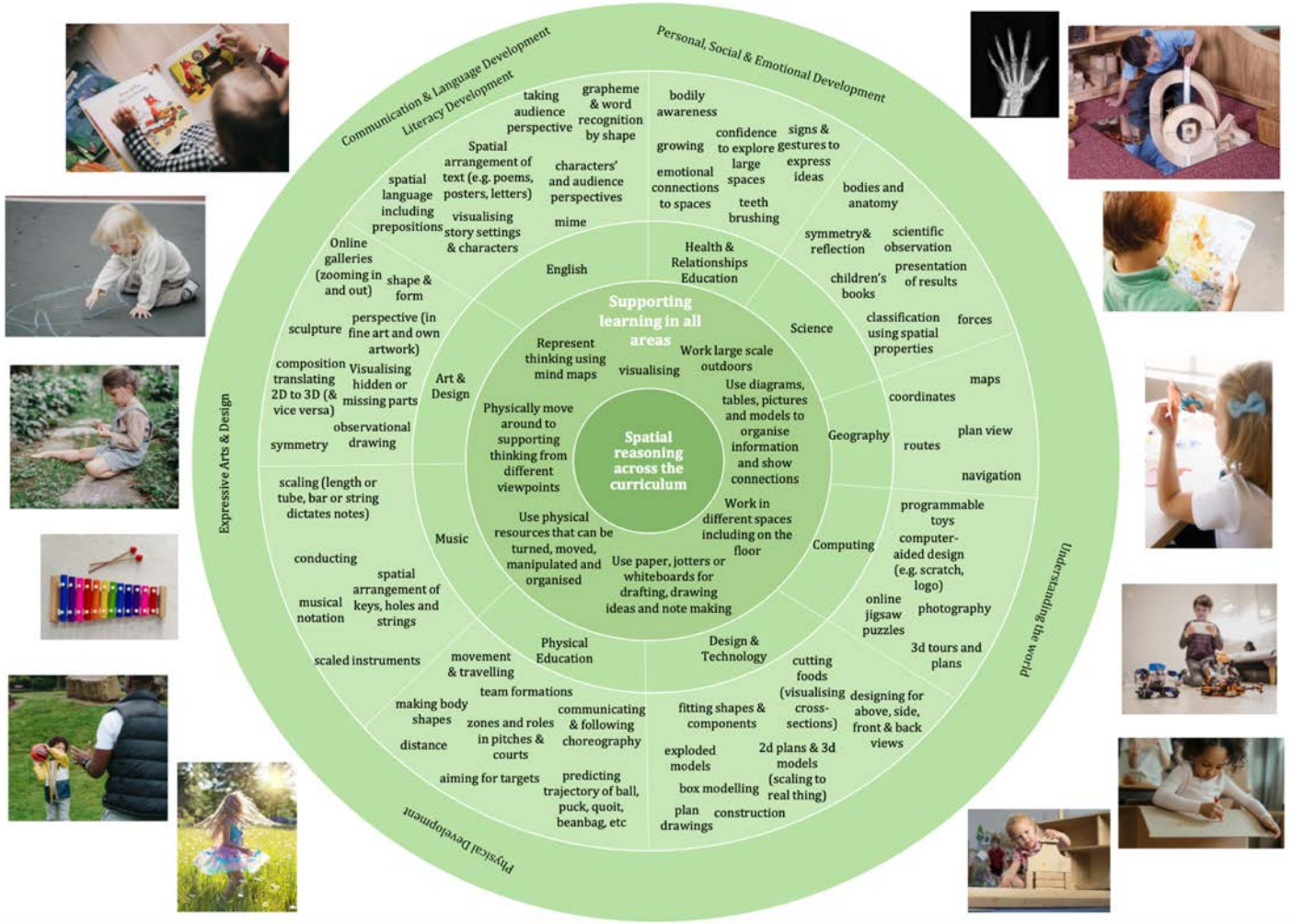
Chemists - periodic table is organised spatially to demonstrate the relationships among elements

Mathematicians use graphs to visualise patterns in data

Strong spatial-reasoning skills:

- more likely to be interested in science and maths
- more likely to choose degrees in STEM subjects
- more likely to be good at STEM research / STEM careers

Spatial reasoning is important across the curriculum



ECMG

earlymaths.org

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Spatial reasoning is fundamental to mathematical thinking

Research shows that it is young children's spatial rather than their numerical abilities that predict their overall, later mathematics achievement.

Higher mathematics scores in PISA for **15-year-olds** are significantly correlated with better spatial cognition (Sorby & Panther, 2020)

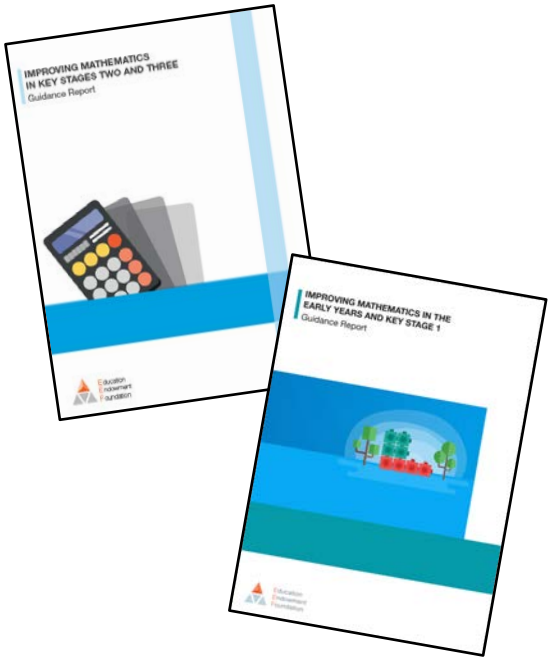
"The relation between spatial ability and mathematics is so well established that it no longer makes sense to ask whether they are related."

(Mix & Cheng, 2012)

The relationship between spatial reasoning and maths goes beyond geometry and block play. Maths relies heavily on spatial relations (number lines, patterns, measurements, quantitative magnitudes) and spatial structure can be used to organise number and for comparing, portioning and combining numbers.

(Farran, 2021)

AND …it will improve subject knowledge…



Excellent maths teaching requires good content knowledge, but this is not sufficient. Excellent teachers also know the ways in which pupils learn mathematics and the difficulties they are likely to encounter, and how mathematics can be most effectively taught.

Effective mathematics teaching requires knowledge of mathematics pedagogy and learning as well as of mathematics itself. This includes knowledge of how children learn mathematical concepts, connections between mathematical concepts, likely difficulties children may have, and different approaches to solving problems or tasks.

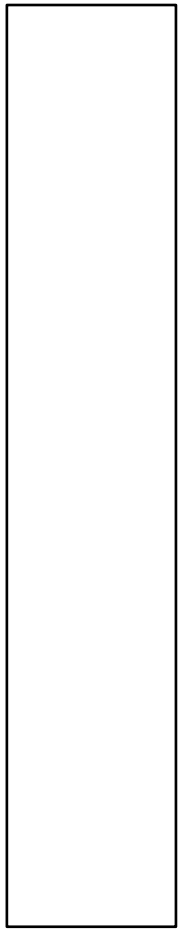
https://educationendowmentfoundation.org.uk/tools/guidance-reports/maths-ks-2-3
https://educationendowmentfoundation.org.uk/education-evidence/guidance-reports/early-maths

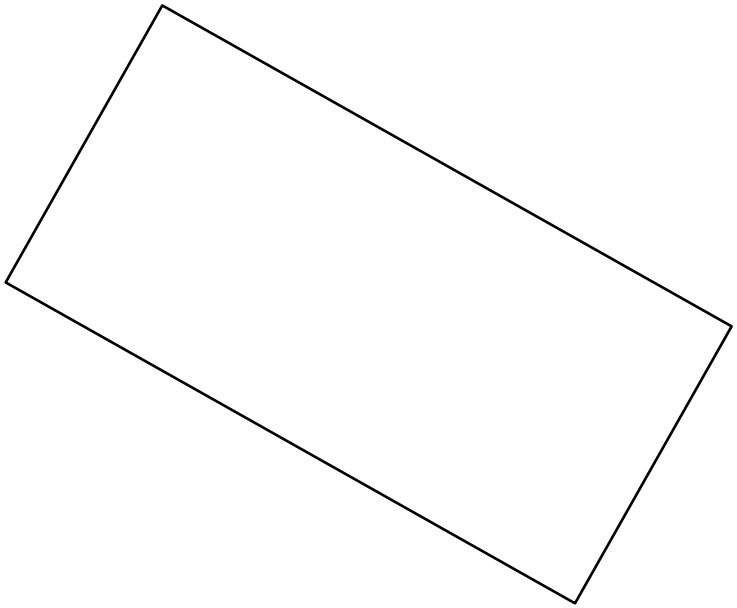
What do teachers of mathematics need to know and how do they need to know it?

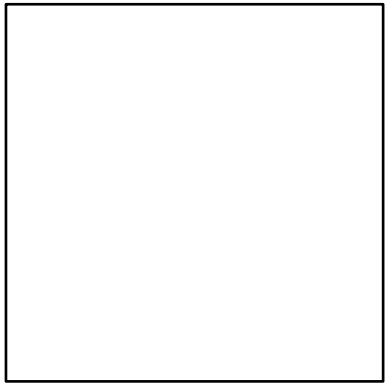
…whilst formal academic qualifications are important, they are not sufficient alone for successful teaching. Teachers need a wider, more nuanced, specialised knowledge of the subject, which relates to the curriculum and the needs of their students.

It is not sufficient to 'know' some mathematics oneself: one needs, amongst other things, to be able to 'unpack' the ideas in order to make them accessible to learners, to be able to make careful choices of examples and tasks, and to be able to respond flexibly to the responses of students to those tasks.

(Campton and Stevenson, 2014)





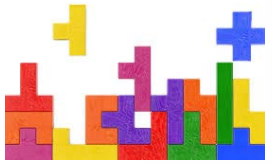


Careful choice of examples

Exploring different aspects of spatial reasoning

- interpreting **appearances**: *deducing the shape and size of objects*
- awareness of **relationships** and variations: *different kinds of positions, directions or orientations*
- **language**: *hearing, describing, directing*
- **manipulating** mentally: *memory, prediction*
- **generalising** and decision making: *abstracting relationships and rules*

- **representations**: *visualising mentally understanding perspective and movements, drawing models and diagrams*



Early Childhood Mathematics Group (2020)
https://earlymaths.org

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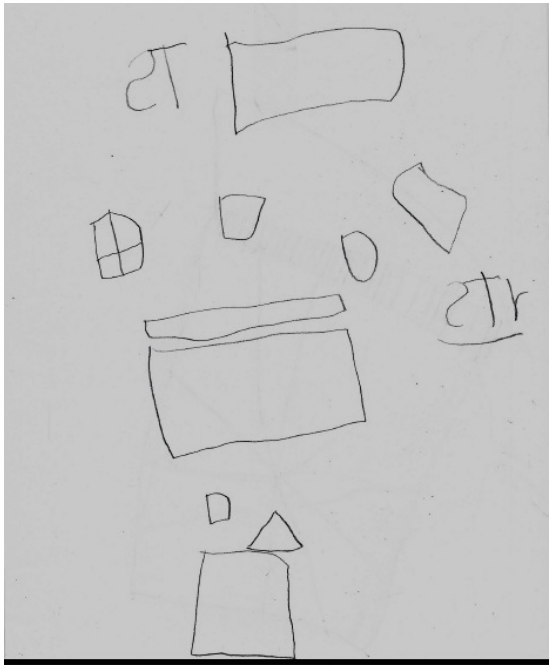
Spatial Reasoning



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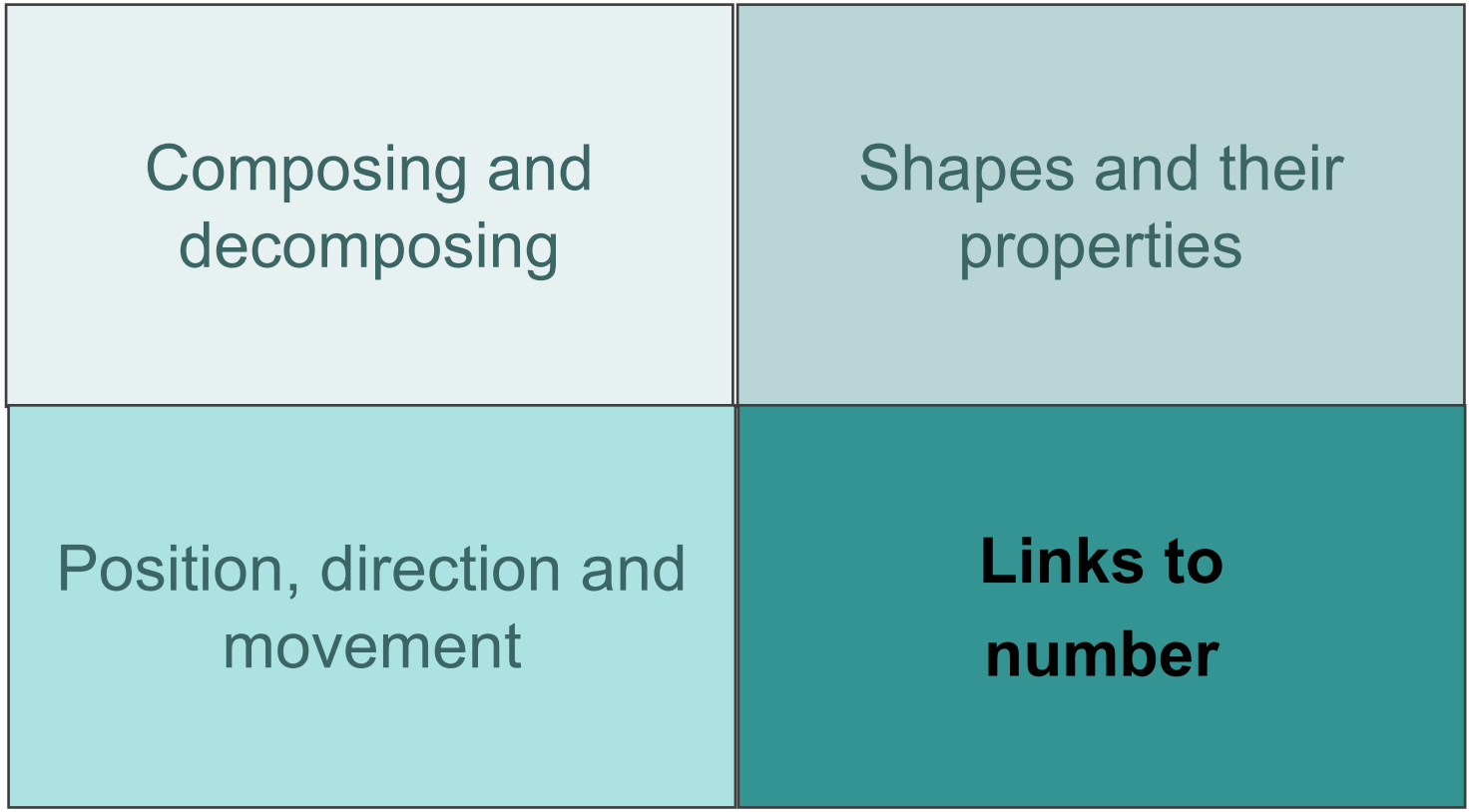
Composing and decomposing
Shapes and their properties
Position, direction and movement
Links to number

Composing and decomposing

https://earlymath.erikson.edu/composing-shapes-with-child-12-math-challenge-puzzles/

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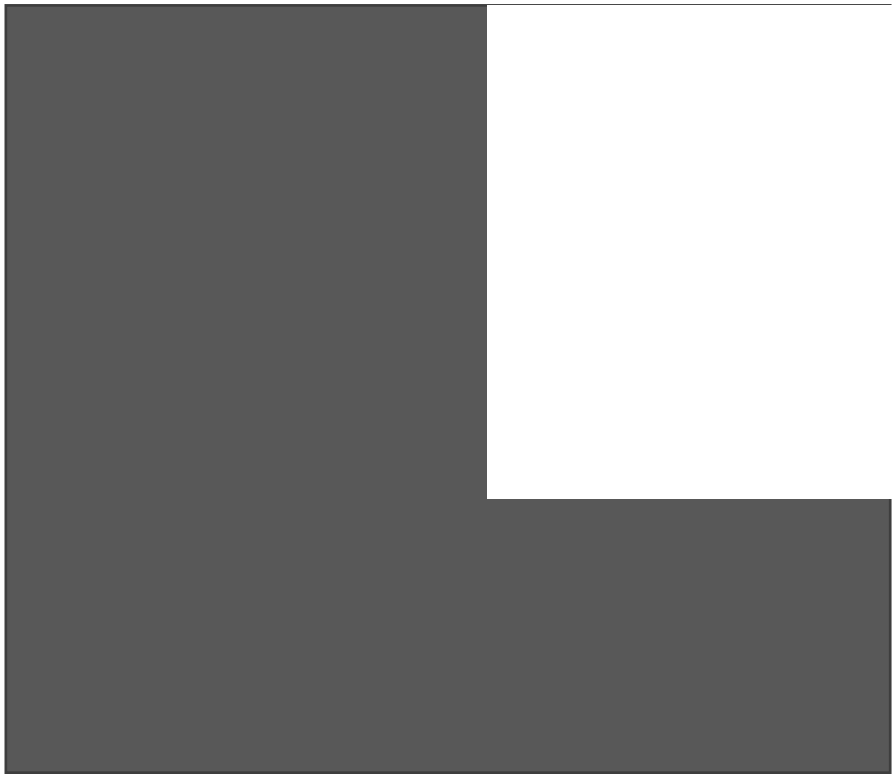
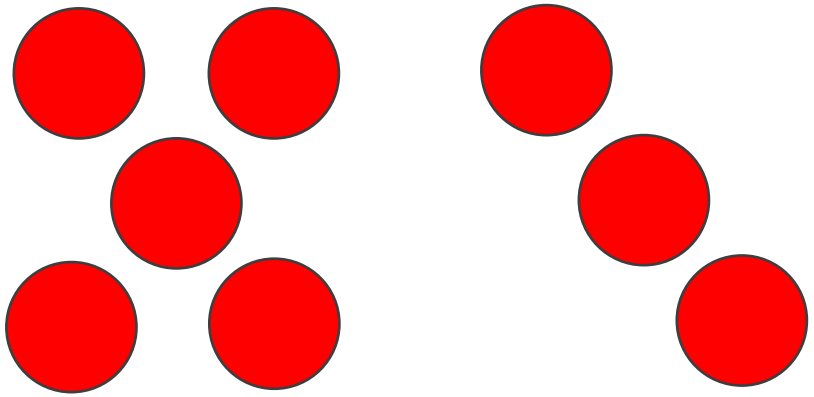
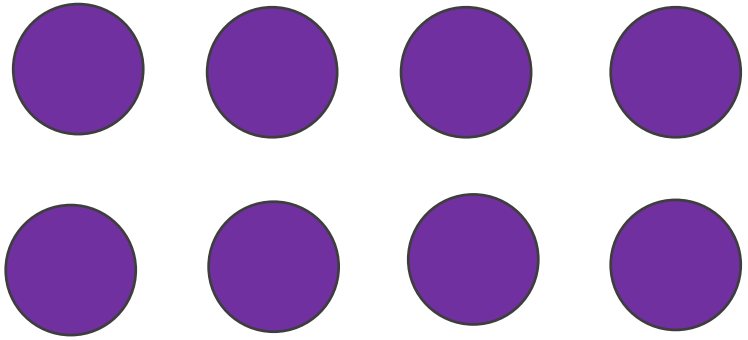


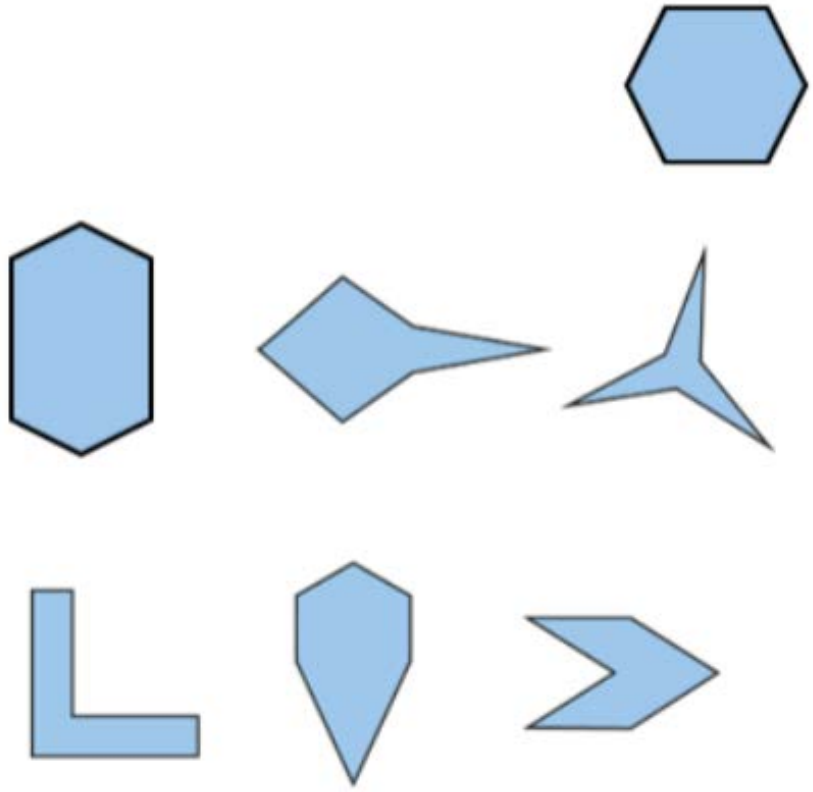
Composing and decomposing





Shapes and their properties

What do you see?



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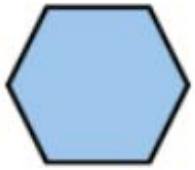
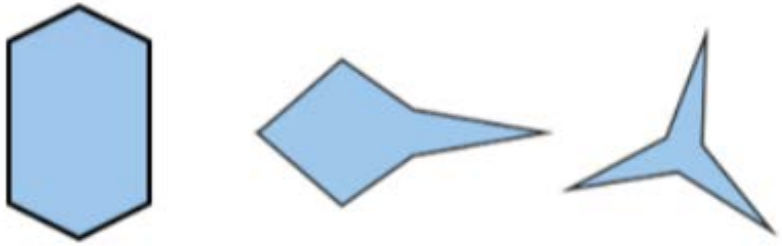
Shapes and their properties

All sides equal length
Not all angles equal size





it must be

it can't be

it could be

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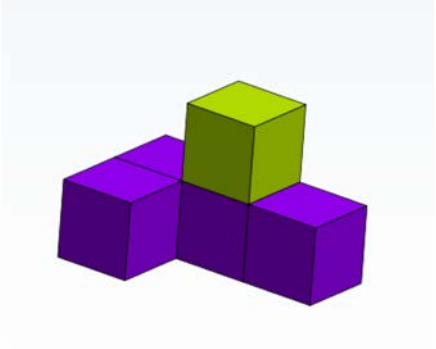
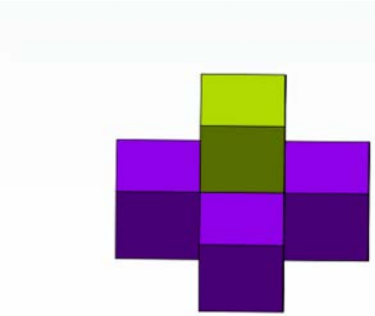
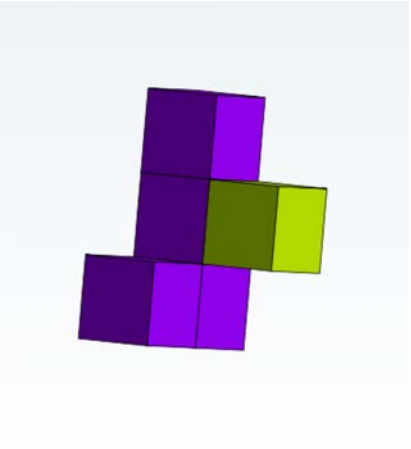
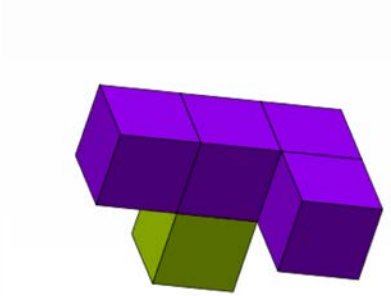
Position, direction and movement









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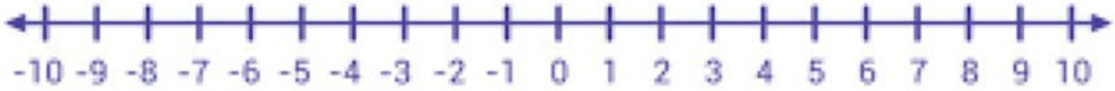
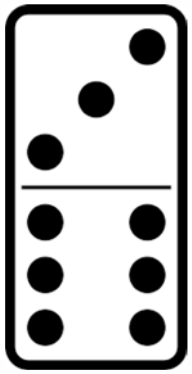
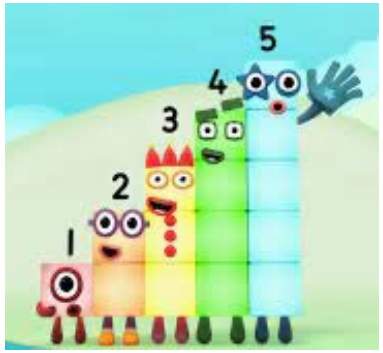
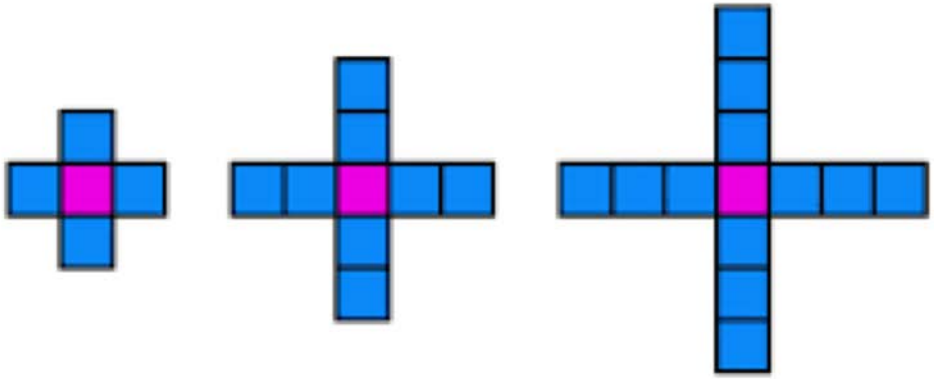
Linking to Number





Where is the spatial reasoning in these images?

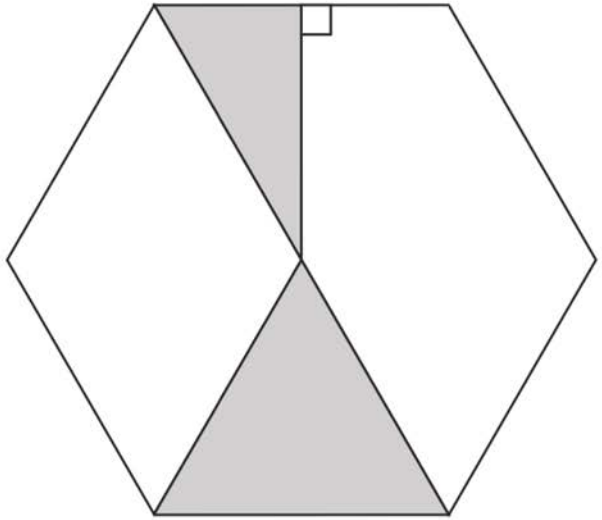




Linking to Number

Here is a regular hexagon.

The area of the large shaded triangle is double the area of the small shaded triangle.



What **fraction** of the whole hexagon is the shaded area?

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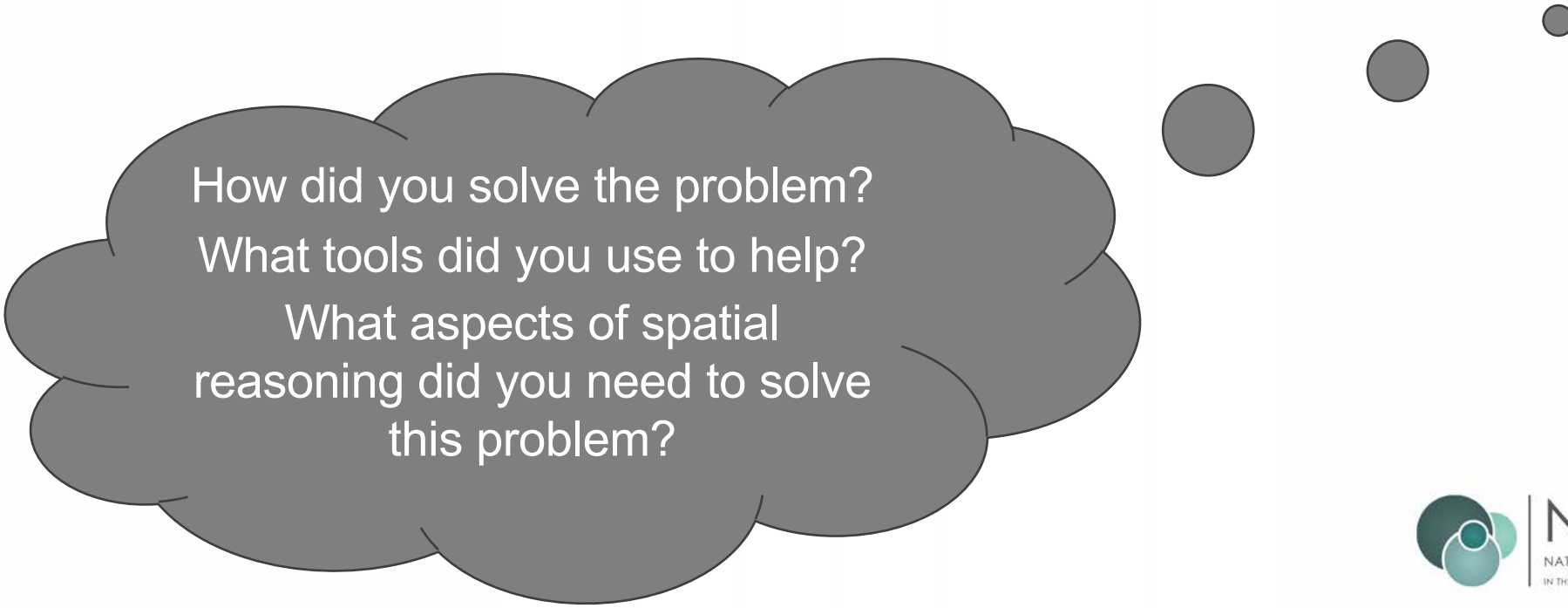
Solving Problems

A balloon first rose 200 metres from the ground, then moved 100 metres to the east, then dropped 100 metres. It then travelled 50 metres to the east, and finally dropped straight to the ground. How far was the balloon from its original starting place?



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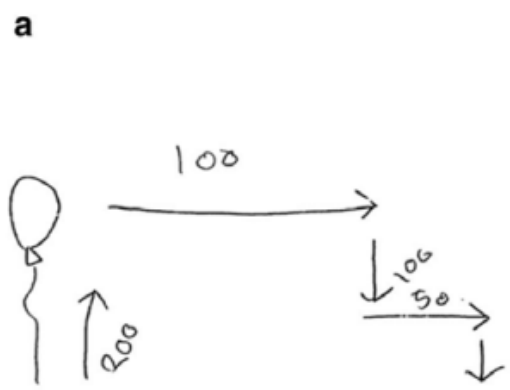
What is the same and what is different between these children's representations (and yours)?

Creating such diagrams can help to solve unfamiliar problems: interestingly, children who are good at visualising draw effective diagrams with less pictorial detail than those who are not so good at visualizing.

(Hegarty & Kozhevnikov, 1999)



Is one representation more likely to lead to a correct answer?

Source: Hawes and Ansari (2020)

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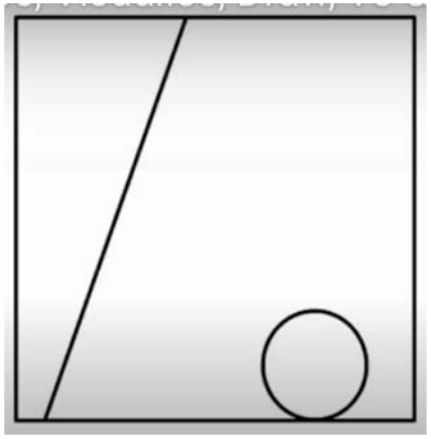
Visualising



Representing

Imagine a square. Put an equilateral triangle on each side. Describe the shape you have now.

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198 + 45 =

203 – 187 =

Some quotes from last year..

The work group really opened my eyes to the importance of teaching shape and space to children despite the continued focus on number in most schools.

It was wonderful to see one of my focus pupils grow in confidence and capability through working with her on her spatial reasoning and visualisation skills.

I was especially interested in the visualisation aspect of the programme and I strongly feel we should give more emphasis to teaching these strategies in school.

In the classroom I used variation to design learning about shapes so that the children could see a range of shapes in different orientations as well as ones that have curved edges and that are not complete. This really helped so that the children were able to get a better understanding of the properties of shape so that they could explain them. What it is, what it is not helped because they could use what they had learnt and explain it.

Some quotes from last year..

I noticed some of the children were reluctant to use their hands and gesture initially when visualising but all by the end of the work group were joining in more confidently.

During my own practice I have noticed how using gesture and correct language have really supported me to embed understanding with children in my class. They now are copying the hand gestures to reiterate their understanding.

The children have enjoyed this different type of problem solving and are more willing to use visualisation, manipulatives or gestures to support their learning.

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How much focus is there on spatial reasoning in your curriculum?

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If you are interested in applying for a place(s) for your school, please follow the link..

https://www.emsmathshub.org.uk/professional-development/pd-2023-24/early-years-and-primary-2023-24/

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