A Guide to...

GEOMETRY

Why Teach Geometry and Spatial Thinking?

- Number and Geometry combine when measuring. You need to measure shapes and objects.
- Some students who have trouble in number excel in spatial thinking. Many of those students enjoy the practical 'hands on experiences' rather than performing paper and pencil calculations.
- Spatial awareness is required to understand number lines the key to understanding magnitude in number.
- It is required for spatial reasoning.
- There is some evidence to suggest student achievement in mathematics is related to spatial thinking and a lack of geometry and spatial skills can impede progress.
- It is used in many workplaces.

The video course at *drpaulswan.com.au/video-pl* on Geometry goes further into this topic. The video PL is 45 minutes long, perfect as a staff meeting replacement. The video may be watched and rewatched by staff members, including upskilling new staff.

Teaching Geometry

Geometry or Space in primary school is about three ideas:

- What is it? - The naming and features of shapes and objects.
- Where is it? - Location
- How does it move or change? - Transformation

What does the Research Say?

For a succinct overview of the teaching of Geometry see https://www.cambridgemaths.org/Images/espresso_27_spatial_skills.pdf

This research is part of the Cambridge Expresso series. The series aims to summarise the research and provide it in a two-page overview. Basically, the research has been 'filtered' by academics.

In essence it says that Spatial Skills are used in other parts of mathematics and can impact on success in learning mathematics and when problem solving. Take time to read the article.

What is it?

There is more to Geometry than naming two-dimensional shapes and three-dimensional objects and learning definitions. Young students begin by learning shape names and sorting and classifying shapes and objects according to certain criteria. Later students learn more about the properties of shapes.

Here are some criteria that students might use when sorting:

Two-dimensional shape and three-dimensional object.

Shape families: triangles, quadrilaterals, pentagons, ...gon

Within each shape family there will be regular and irregular shapes. For example, the only regular triangle is an equilateral triangle, and the only regular quadrilateral is the square.

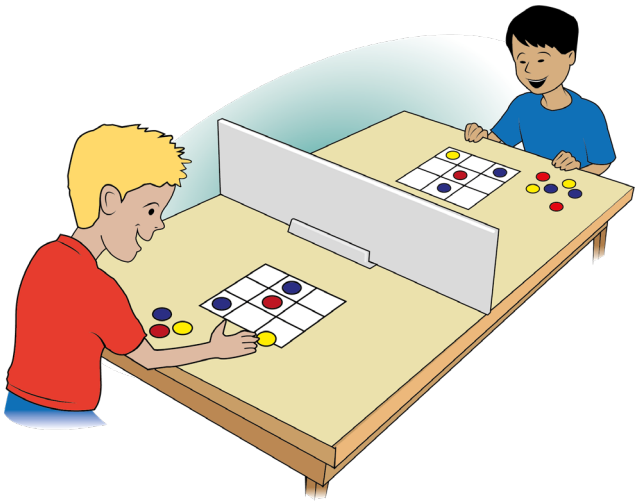
The game 'Get in Shape' was designed to highlight the difference between regular and irregular shapes.

As students' vocabulary develops students can classify shapes and objects. For example, a triangle may be classified accord to angle type or sides (laterals) or both. For example, a triangle might be referred to as a right-angle isosceles triangle.

The implication is that students will need to be exposed to many words and associated images.

Where is it?

The ability to locate an item is fundamental. Young students often used vague terms such as "it is over there" to describe the position of an item. As student vocabulary develops, they can be more precise in their descriptions using phrases like "next to, above, below ..." These words are known as prepositions. A list of common prepositions is provided as an appendix.



Eventually students use coordinate systems to describe the position of shapes and objects.
The game Battleship is and example of a 'Barrier Game' involving the use of co-ordinates. Note depending on how you use a barrier game you could be describing shapes and objects in terms of what it is, where it is and even possibly how to move it or rotate them.

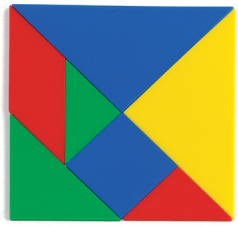
How does it Move or Change?

This refers to the change of position of a shape or object by sliding it (translating it) or turning it (rotating it) or flipping it (reflecting it). These transformations may be combined to change the position of shape or object.

Some students experience difficulty visualising transformations and do not appreciate that when an shape is rotated, reflected or slid along a surface the shape does not change. It is the same size and shape as when it started (congruent). When rotating a square some students may not appreciate that it does not

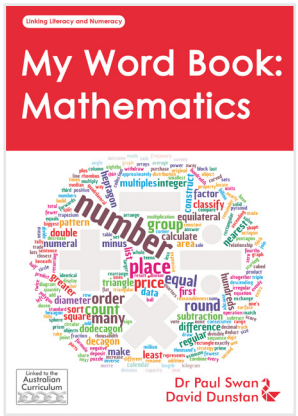
A shape may be transformed by enlarging or reducing the size of it. One way of doing this is to copy and image using a grid. If an image is shown on a 10 mm grid and copied onto a 20 mm grid it will be enlarged. An image may also be projected as a means of enlarging it. When enlarging or reducing an image the dimensions change and as a result the perimeter and area. Here is an example of the link between geometry, measurement, and number.

Using Manipulatives

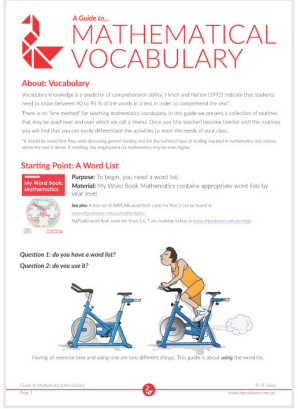


Teaching Geometry in the primary use will involve lots of hands-on experiences from paper-folding and cutting to using mirrors and miras/ georeflectors. The appendix of this guide contains an alphabetical listing of manipulatives designed to support the teaching of geometry. Students will need to be taught how to use these manipulatives along with the associated language.

Mathematical Literacy



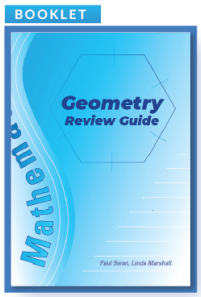
There is a considerable vocabulary that students need to develop if they are to experience success in Geometry. The vocabulary develops from simple everyday language such as box to more precise words such as rectangular prism. A full list of spatial vocabulary listed by Year level and subtopic may be found in ***My Word Book: Mathematics***.



Geometry draws on a second mathematical literacy – graphics. The images and diagrams used once again range from simple to precise. Young children's drawings of a triangle will differ considerably from a diagram of a triangle that is labelled. The later will likely include symbols – a third mathematical literacy. Consider how when solving problems students are told to 'draw a diagram' and label it.

See also: ***A Guide to Mathematical Vocabulary***

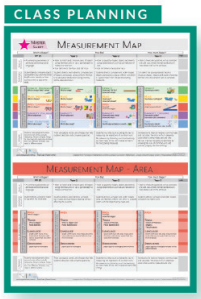
Further Support



Geometry Review Guide

Free Download from www.drpaulswan.com.au/resources

This booklet reviews all of the key ideas in Geometry.



Geometry Maps

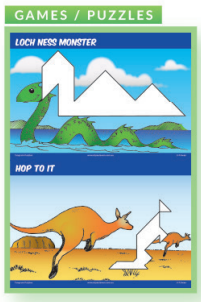
Free Download from www.drpaulswan.com.au/resources

The Geometry Maps will help assist with planning.

Geometry Curriculum Threads

Free Download from www.drpaulswan.com.au/resources

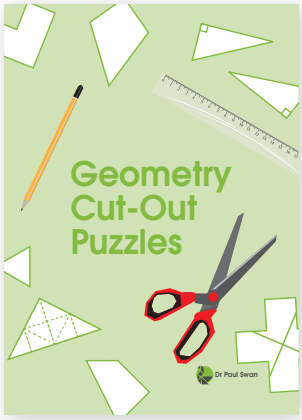
Planning assistant that visually maps out the geometry curriculum.



Tangram Task Cards

Free Download from www.drpaulswan.com.au/resources

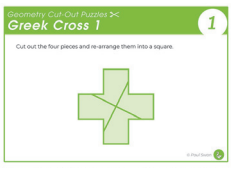
A set of activity cards you can use with tangrams as a geometry activity.



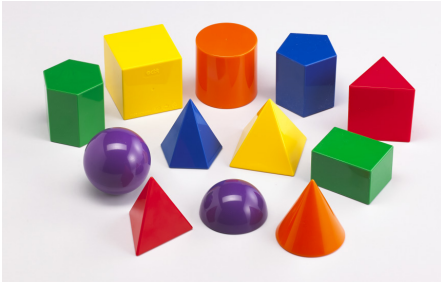
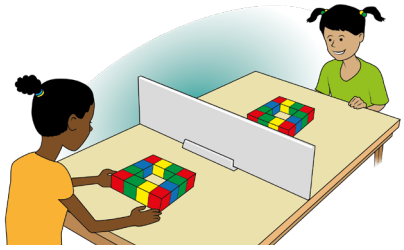
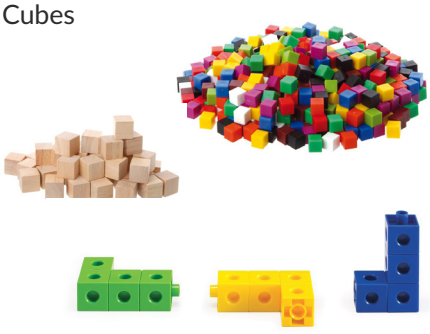
Geometry Cut-Out Puzzles

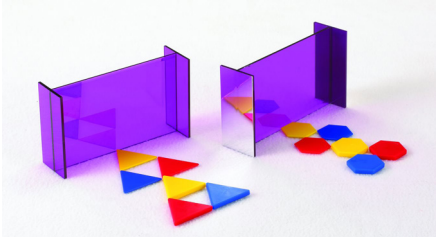
Purchase from www.drpaulswan.com.au/shop

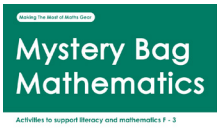
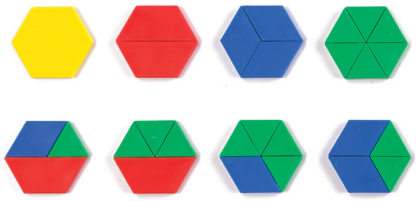
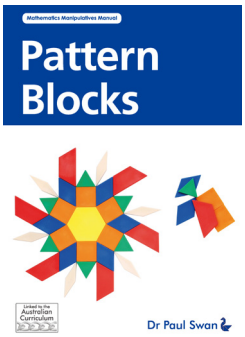
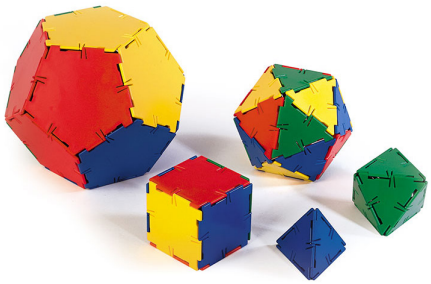
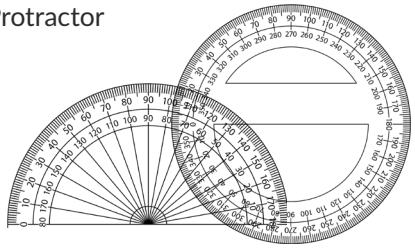
A set of activity cards made to explore geometry concepts in a fun and engaging way. Includes answers.

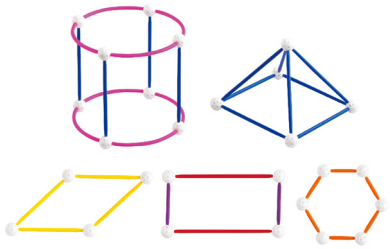
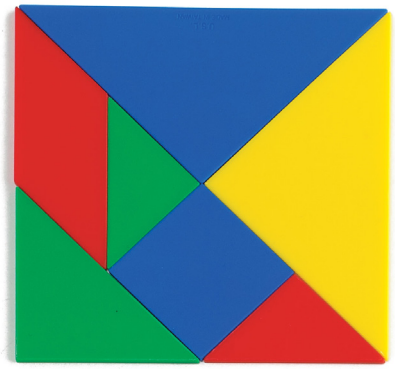
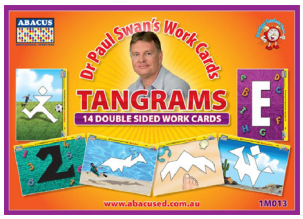
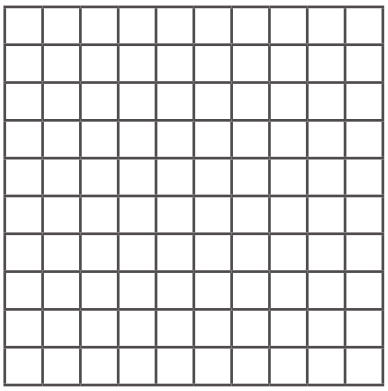


More titles go with specific manipulative materials.

Manipulative	AC Links	Comments
3D Object Solids 	F: Sort, describe and name familiar ... three-dimensional objects in the environment (ACMMG009) Yr 1: Recognise and classify familiar ... three-dimensional objects using obvious features (ACMMG022) Yr 2: Describe the features of three-dimensional objects (ACMMG043)	You will need a variety of sets of 3D objects. A small set can be used inside the Mystery Bag (see later).
Barrier Games 	F: Describe position and movement (ACMMG010) Yr 1: Give and follow directions ... (ACMMG023)	Barrier Games are an example of a routine that may be differentiated and used right across the school. The quintessential barrier game is Battleship. 
Cubes 	Yr 3: Make models of three-dimensional objects and describe key features (ACMMG063) Yr 6: Construct simple prisms ... (ACMMG140)	2 cm wooden cubes 2 cm linking cubes - check that they link on all sides 1 cm cubes. “Centicube” This same manipulative may be used in measurement, number and probability lessons.
Colour Tiles 	See page 4 of Colour Tiles for a comprehensive listing of AC Links.	See ***Colour Tiles*** Book 

Geoland 	Yr 3: Identify angles as measures of turn and compare angle sizes in everyday situations (ACMMG064) Yr 5: Describe translations, reflections and rotations of two-dimensional shapes. Identify line and rotational symmetries (ACMMG114)	If you don't have access to a hinged mirror then two mirrors may be joined with tape to create a basic hinged mirror.
Geoboard 	See page 4 of Geoboard Gems for a comprehensive listing of AC Links.	See also: ***Geoboard Gems*** Geoboard Cards Virtual Geoboard 
Geostix 	Yr3: Identify angles as measures of turn and compare angle sizes in everyday situations (ACMMG064) Yr 4: Compare angles and classify them as equal to, greater than or less than a right angle (ACMMG089) Yr 6: Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles (ACMMG141)	Ideal for geometric reasoning with angles.
Mirrors  Geo-mirror 	Yr 5: Describe translations, reflections and rotations of two-dimensional shapes. Identify line and rotational symmetries (ACMMG114)	Mirrors will assist in determining the lines of symmetry on a 2D shape. The Georeflector is a 'mirror that you can see through'.

Mystery Bag 	F: Sort, describe and name familiar two-dimensional shapes and three-dimensional objects in the environment (ACMMG009) Yr 1: Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features (ACMMG022) Yr 2: Describe the features of three-dimensional objects (ACMMG043)	Also Known as a "Feely Bag" Items such as 3D objects need to be placed inside the bag and children asked to describe what is inside the bag.  See also:  ***Mystery Bag Mathematics*** Book 
Pattern Blocks  	Yr 2: Investigate the effect of one-step slides and flips (ACMMG045) Yr 2: Identify and describe half and quarter turns (ACMMG046) Yr 4: Compare and describe two dimensional shapes that result from combining and splitting common shapes (ACMMG088) Yr 4: Create symmetrical patterns, pictures and shapes (ACMMG091)	See also: ***Pattern Blocks*** Book  Pattern Block Cards https://www.abacused.com.au/sale/pattern-blocks-cards-dr-paul-swan
Polydron 	Yr 5: Connect three-dimensional objects with their nets and other two-dimensional representations (ACMMG111) Yr 6: Construct simple prisms and pyramids (ACMMG140)	Ideal for visualising 2D nets being folded to create 3D objects.
Protractor 	Yr 5: Estimate, measure and compare angles using degrees. Construct angles using a protractor (ACMMG112)	I prefer a proper 360 degree protractor. It helps to establish that there are 360 degrees in a circle and avoids issues with the double scale.

Skeletal Geoset 	Yr6: Construct simple prisms and pyramids (ACMMG140) Yr 3: Make models of three-dimensional objects and describe key features (ACMMG063)	Toothpicks and frozen peas or bluetac may be used to construct simple prisms and pyramids.
Tangram 	For a full listing see the AC Links for Toying with Tangrams see the store page for the book. Here is a sample: Yr 2: Investigate the effect of one-step slides and flips with and without digital technologies (ACMMG045) YR 2: Identify and describe half and quarter turns (ACMMG046) Yr4: Compare and describe two dimensional shapes that result from combining and splitting common shapes, with and without the use of digital technologies (ACMMG088)	See also: ***Toying with Tangrams*** Book  Tangram Cards (Abacus.com.au) 
Whiteboard Grid 	Yr 3: Create and interpret simple grid maps to show position and pathways (ACMMG065) Yr5: Use a grid reference system to describe locations. Describe routes using landmarks and directional language (ACMMG113) Yr 6: Introduce the Cartesian coordinate system using all four quadrants (ACMMG143)	Note Grid position is different to co-ordinate position. Grid position relates to the area inside the square that is named. Co-ordinates refer to a specific point.

For a general overview of mathematics manipulatives see Mathsmaterials.com