Meaningful Geometry in Early Childhood
Pre-K to Grade 2

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What is geometry?
Geometry is the study of patterns and relationships in shape, position, orientation and size. (for school curriculum)
• Geometry is in Art All Over the World.
• It is all around us.
Why teach geometry?

• Because it’s fun!
  1. What is a tetromino? (Defining terms)
  2. Are they the same? (Congruence)
  3. Good strategies for play? (Spatial sense)
  4. Am I getting better? (Statistics)
Why is geometry in Elementary School?

• Because it has practical applications
  – Why are nuts and honeycomb hexagonal?
  – Why aren’t manhole covers square?
Why learn geometry?

Because it develops our spatial thinking, sense, and abilities.

- Spatial visualisation and orientation (McGee, 1979)
- Spatial ability is a factor of intelligence and an important predicator of future careers especially in scientific research, engineering and the arts. (Ivie & Embreston, 2010)
Del Grande’s Spatial Perceptions

• The foundational abilities needed to create and interpret spatial symbol systems are based on spatial perception.

• According to Del Grande (1993) these abilities are:
  1. Eye motor co-ordination
  2. Figure ground perception
  3. Perceptual constancy
  4. Position in space perception
  5. Perception of spatial relationships
  6. Visual discrimination
  7. Visual memory
1. Eye-motor coordination:

The ability to coordinate the eye with other parts of the body in various activities.

**Gross motor** – e.g. completing an obstacle course

**Fine motor** – e.g. using pencils, rulers

**Activities:**
Physical activities and games, tracing, handwriting, computer mouse manipulation ...
2. Figure-ground perception:

- The visual act of identifying a figure against a complex background.

Where is Wally?
Can you find me?
Find the word “English”

Word Search

Finish the figure in B to look like A.
3. Perceptual constancy:

The ability to recognise figures or objects in space, regardless of size, position, or orientation.

Which camera sees which picture?

- 3 figures below can be fitted together to make a square like the one in the box
- Mark the pieces with an X
4. Position-in-space perception:
The ability to relate an object in space to oneself. Using a spatial relationship for interpretation.

Activities:
• Interpretation of letters depends on the relationship to the top and side of the page
• Identifying constellations in the night sky e.g. Southern Cross
5. Perception of spatial relationships

The ability to see two or more objects in relation to oneself or in relation to each other.
6. Visual discrimination

The ability to distinguish the similarities and differences between or among objects. It is independent of position.

A square

Is this a square
7. Visual memory

The ability to recall objects no longer in view.

**Activities:**

- memory games
- draw what is known not what is seen
Concepts in Geometry

*Early Childhood*

- movement in space
- location and direction
- three-dimensional objects
- two-dimensional shapes

*Middle Elementary*

- platonic solids
- transformations
- symmetry
- tessellations

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Location and Direction

I Spy

Where is Hare?
outside
Classroom Path

R or B
R or P
B or G
G or O
Most important aspects of geometry for early childhood is that geometrical shapes possess **critical attributes** - must haves.

A cube might be purple or little but it must have six faces.

A triangle might have different orientations but it must have three sides and three corners.
Collect Three-dimensional objects to create a geometry resources box.
Properties of 3D objects

Roll or not roll
Rock or not rock
Rough, smooth pointed, vertices, faces, edges
Regularity
Flat or curved surfaces
Solid v Open construction
Prisms

Prisms are made of congruent shapes (same size and shape)
Pyramids

Only one base
All other faces are triangular
Common vertex (apex)
Pyramids are named according to the shape of their base:

– Triangular-based pyramid
– Square-based pyramid
– Rectangular-based pyramid
– Pentagonal-based pyramid
Pyramids

Pyramids are similar shapes (same shape different size) – getting smaller toward the vertex

Triangular based pyramid
Cones

Related to a pyramid
Circular base
A vertex (apex)
A curved surface from circular base to vertex
Height found by a perpendicular line from apex to the base plane
Cylinders

Related to a prism (like cone is to a pyramid)
Has two congruent circular and parallel bases
A curved surface linking the two bases
Height found by drawing a perpendicular line from the top base plane to the bottom base plane
cylinder

not cylinder
Spheres
Completely curved surface
No edges
No vertices
Same distance from center to any point on its surface
The **characteristics, attributes or features** are more important than the names of the objects and shapes.

- similarities and differences
- straight and curved surfaces or faces
- roll, stack, number of faces, corners, edges
- number of sides and angles
Two-Dimensional Shapes
Two-Dimensional Shapes

The starting point for studying 2D geometry with young children is by locating and examining the faces of 3D objects in their world.

Three-dimensional objects before
Two-dimensional shapes

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Three-dimensional Objects
Muddy Muddy Mess

before

Two-dimensional Shapes
What shapes are in Angie’s picture?
What did she use to print each shape?
Language of shape
The language that comes from using geometric concrete and pictorial materials.

Verbalising helps to articulate consciously what might be otherwise vague and undeveloped ideas.

It can reveal immature and misconceived ideas.

Children should first use their own terms:

- corner – angle
- slanty – sides of parallelogram
- straight - parallel
Two-Dimensional Shapes

It lies in a single plane
It is closed not open like
It is simple not complex like a figure 8
It is composed of straight and curved line segments
Use pipe-cleaners, string, plastic coated wire and elastic to make the outline of Two-dimensional shapes.
Polygons

A simple closed figure consisting of 3 or more vertices

Poly (many) + gonia (angles)

Polygons are named from their number of sides or angles

Is a circle a polygon?
Draw a triangle

• Now write a definition of a triangle

• Share your definition with someone near you.

• What was the same / different / similar?

• What properties are critical when describing a triangle?
Which of these are triangles?
A quote:
Students do misunderstand, but it is seldom because they cannot understand, most often it is because they understand something else.  

Tripp, D (1993)

Good questions / tasks can assist teachers to identify what students understand. Students can get the right answers for the wrong reasons.
Which of these shapes are triangles? Mark each triangle with a \( \checkmark \)

What is this child’s definition of triangle?

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Critical and non-critical properties

Critical properties are the ones a shape must have.

Non-critical properties can confuse students.

Many students include non-critical attributes in their definitions.

Many students develop their own definitions through observation and deduction.
Angle

Right - 90 degrees

Acute – less than 90 degrees

Obtuse – more than 90 and less than 180 degrees

Straight – 180 degrees

Reflex – more than 180 degrees
Which type of angle is this?

Answer: more information please... which angle are you asking about??

Beware of prepared activities and worksheets that assume an internal angle and therefore acute as the answer when a student would be correct responding reflex!
Triangles (1)

Can be described by size of angles

Acute-angled triangle

Right-angled triangle

Obtuse-angled triangle
Triangles (2)

Can be described by size of sides

Scalene (no sides equal)

Isosceles (2 sides equal)

Equilateral (all sides equal – all angles = 60°)
Draw a rectangle

• Write a definition of a rectangle

• Share it with someone near you....

• What was the same / different / similar?

• What properties are critical when describing a rectangle?
Which of these shapes are rectangles? Mark each rectangle with a ✓

What is this child’s definition of rectangle?

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Which of these shapes are rectangles? Mark each rectangle with a ✓

What is this child’s definition of rectangle?
Which of these shapes are rectangles? Mark each rectangle with a ✓

What is this child’s definition of rectangle?

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Student misconceptions

• Gradually they should be introduced to standard terminology. Conversation will reveal misconceptions:

A right angle
A square

A left angle (incorrect)
Not a square

• In all cases, asking children how they know, is important. What beliefs / understandings do they have?
Properties of a Rectangle

**Critical properties**

- Has 4 sides
- The sides are perpendicular (meet at right angles)
- Its corners are right angles

**Non-critical properties**

- Has two long sides and two short sides
- Is taller than it is wide
- Has a length and a width
- Stands upright
- Has blue lines for sides

So is a square a rectangle?
Families of 2D shapes (polygons)

Triangles
  – equilateral
  – isosceles
  – Scalene

Quadrilaterals
  – Parallelograms
    • rectangle
    • Rhombus
Quadrilaterals

Closed, simple shape
Has 4 vertices
Has 4 sides
Parallelograms

Quadrilaterals with opposite sides parallel
Rhombus

Is a **parallelogram** with all sides equal
Rectangle

Is a parallelogram with each angle 90 degrees
Square

a rectangle with four equal length sides

or

a rhombus with each angle equal to 90 degrees
Concepts in Geometry

**Early Childhood**

movement in space
location and direction
three-dimensional objects
two-dimensional shapes

**Middle Elementary**

platonic solids
transformations
symmetry
tessellations
More than 60 percent of commercial geometry books for children have incorrect representation and language for three-dimensional objects and two-dimensional shapes.
Enjoy exploring geometry with your current students.

Work together to discover new ideas to expand their knowledge and interaction with the real world.