

Guidance note

Geometry – geometrical reasoning

This material has been written to support a mathematics teacher in a mainstream classroom. The context is a geometry unit which might address some or all of these objectives:

- *know that if two 2-D shapes are congruent, corresponding sides and angles are equal (Y8)*
- *solve geometrical problems using side and angle properties of equilateral, isosceles and right-angled triangles and special quadrilaterals, explaining reasoning with diagrams and text; classify quadrilaterals by their geometrical properties (Y8)*

All pupils have an entitlement to explore these ideas.

Pupils working at level 3 and below can access these relatively sophisticated concepts and make links between them if they are given the resources and activities to support their thinking and developing understanding.

Possible barriers to progress can be tackled using approaches such as those described below. These materials offer a starting point and are not the only way to address the difficulties highlighted here. Teachers know their pupils and will bring to these suggestions their own ideas and creative approaches.

The guidance is presented in a consistent format, describing the potential barrier to progress, and then offering ideas for teaching and questions which can support the suggested pupil activities and opportunities for mathematical talk. Finally, supporting resources are listed and a range of relevant assessment criteria is shown.

It should be noted that where primary resources and support are referenced content will need to be adapted to ensure age-appropriateness.

Geometry and measures objective *know that if two 2-D shapes are congruent, corresponding sides and angles are equal (Y8)*

Possible barrier Pupils do not understand that an angle is a dynamic measurement of turn and is not a shape.

Teaching ideas and questions

For a useful starter activity to encourage communication of both positional and directional movement ask pupils:

- *If I move this object like this, how could I describe the movement to a friend on the telephone so they could copy the movement?*

Discuss the concept of turning through an angle, raised through questions such as:

- *Where do you see things that turn?*
- *Choose one of these and tell me about the angles through which it turns.*
- *How could we measure the amount of turn?*
- *What units do we use for measuring turns?*
- *What equipment might we use?*

Pupil activities and opportunities for mathematical talk

Ask pupils to copy a movement that includes at least one turn. Repeat with different types of movement to explore the vocabulary that pupils know.

Provide instructions to pupils to move from point A to point B in the classroom, including turning through given angles to emphasise the dynamic nature of angles. For example:

- *Go from your desk to the desk nearest the door by turning through 90° clockwise and ...*

Encourage pupils to use other angles to estimate turning through angles, such as 60°, 45°, 20°, and then illustrate their estimation process with diagrams. A clock face provides a useful context for such turns.

Ensure that pupils know how to use tracing paper effectively to make angle comparisons and estimates.

Supporting references/resources

Use practical resources wherever possible. In particular, when working on angle topics, allow pupils to walk through the angles before trying to represent anything on paper.

- geoboards
- square and triangular dotted paper
- a 'right angle' checker (made by pupils themselves)
- matching, sorting activities for shapes, such as bingo or lotto
- tracing paper
- programmable toys, computer simulations and games

The Nrich site includes a free-to-use [virtual geoboard](#).

The Interactive Teaching Program (ITP) *Calculating angles* is available from the [National Strategies website](#); search for the ITP by title.

	L1	L2
	measure and order objects using direct comparison	distinguish between straight and turning movements, recognise right angles in turns and understand angle as a measurement of turn

Geometry and measures objective *solve geometrical problems using side and angle properties of equilateral, isosceles and right-angled triangles and special quadrilaterals, explaining reasoning with diagrams and text (Y8)*

Possible barrier Pupils do not recognise angles greater and less than 90° .

Teaching ideas and questions

Ask pupils:

- *Show me a right angle in the classroom or made with your body.*
- *Turn through an angle of 90° . How do you know that the angle you have turned is 90° ?*
- *Turn through an angle greater than 90° and one less than 90° . Which of your turns was larger? How do you know?*
- *Convince me that you need to turn through two right angles in order to face the opposite direction.*

Show a shape on a geoboard and ask:

- *How can you change this shape so that it has a right angle?*
- *Make a shape of your own with two right angles.*

Show pupils a map and ask:

- *Show me an example of the compass directions you could use to get from ... to*
- *Give different instructions for the same movement.*

Pupil activities and opportunities for mathematical talk

Ask pupils to turn through a right, acute or obtuse angle, and then to try to draw the movement they have made.

Invite pupils to choose, from a collection of shapes, a shape with one right angle, two acute angles, etc. Demonstrate the comparison with right angles (that is, greater than or less than a right angle) for each angle they identify.

Use the 'always/sometimes/never true' strategy to explore statements such as:

- a triangle can have an obtuse angle.
- a triangle cannot have two obtuse angles.

Supporting references/resources

- geostrips
- geoboards
- square and triangular dotted paper
- corners of everyday objects
- a 'right angle' checker (made by pupils themselves)
- matching, sorting activities for shapes, such as bingo or lotto.
- tracing paper

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The Interactive Teaching Program (ITP) *Calculating angles* is available from the [National Strategies website](#); search for the ITP by title.

L1	L1	L2
recognise and use a simple pattern or relationship	use everyday language to describe properties of 2-D and 3-D shapes	distinguish between straight and turning movements, recognise right angles in turns and understand angle as a measurement of turn

Geometry and measures objective *solve geometrical problems using side and angle properties of equilateral, isosceles and right-angled triangles and special quadrilaterals, explaining reasoning with diagrams and text; classify quadrilaterals by their geometrical properties (Y8)*

Possible barrier Pupils find it hard to identify and talk about properties of shapes.

Teaching ideas and questions

With a selection of 2-D shapes available, ask the following questions:

- *Show me a 2-D shape with three sides (or straight sides, a curved side, corners).*
- *Convince me that a shape with three sides has three corners.*
- *Show me a triangle/quadrilateral and another triangle/quadrilateral.*
- *Why is this a triangle/quadrilateral?*
- *What is the same/different about (diagrams of) these two triangles/quadrilaterals?*

- *Is this statement always, sometimes or never true?*
 - A shape with three sides has three corners.
 - A shape with four straight sides is a square.
 - A triangle has a right angle.
 - A triangle has an obtuse angle.

Ask pupils to consider what happens to the properties of shapes when the shapes are reflected:

- *What looks the same and what looks different?*

- *Is this statement always, sometimes or never true?*
 - Rotated shapes are the same size and shape as the original shape.
 - Reflected shapes are the same size and shape as the original shape.

Pupil activities and opportunities for mathematical talk

Make use of the vocabulary of shape properties, such as types of angle, *sides*, *vertices*, *straight*, *parallel*, when describing shapes. Encourage pupils to use appropriate mathematical vocabulary to support their communication of reasoning about shapes.

Invite pupils to identify properties and support them in recording the properties of particular shapes.

Give pupils a range of simple 2-D shapes and ask them to sort them into different piles. Allow them to classify the shapes according to their own classification. Ask them to explain why they have put shapes together in particular groups. Ask what properties they used to help them decide.

Get pupils to make up sets of different sized squares, circles, similar triangles, etc. to compare in order to illustrate that angle properties of shapes stay the same when a shape is enlarged.

Supporting references/resources

Paper folding is a useful strategy for generating a variety of 2-D shapes.

- geostrips
- matching, sorting activities for shapes such as bingo or lotto.
- geoboards

The Nrich site includes a free-to-use [virtual geoboard](#).

P8	L1	L3
respond to mathematical vocabulary such as 'straight', 'circle', 'larger' to describe the shape and size of solids and flat shapes	use everyday language to describe properties of 2-D and 3-D shapes	classify 3-D and 2-D shapes in various ways using mathematical properties such as reflective symmetry for 2-D shapes