Primary
& Early Years
Magazine 69

National Centre
for Excellence in the
Teaching of Mathematics

Welcome to another edition of our new-look and more compact Primary Magazine. This magazine has been serving primary practitioners for 68 editions with a varied collection of different articles related to maths education and mathematics professional development, which are accessible through the Primary Magazine Archive.

Contents

In each edition we have a selection of interesting and useful articles. New National Curriculum in Focus is dedicated to unpicking the new curriculum and how to understand and develop the requirements of the new programmes of study. In this edition we begin with a focus on *fluency, reasoning and problem solving in Geometry in upper KS2*.

Where's the Maths in That? shares ideas for ensuring that mathematics is taught and experienced across the curriculum. In the coming months, this series of articles that will explore opportunities for mathematics and mathematical thinking within the new science programme of study. This month the theme is *Light for Y6.*

Finally, in this edition, Maths in the Staff Room provides some ideas for teaching staff to remind themselves of the ever-present desire to use various assessment methods as a tool for learning.

But first, we have a News section, bringing news from the NCETM and beyond to keep you up to date with the fast-changing world of mathematics education.

News

Maths Hubs

Two teachers from each of the 32 Maths Hubs have now returned from Shanghai after spending two weeks with teacher-trainers at Shanghai Normal University and in Shanghai primary schools, engaging in both lesson observation and paired-teaching. Later in the school year, pairs of Shanghai teachers will return to England to work in the schools of the teachers they hosted, thereby strengthening the professional relationship between the teachers and the exchange of pedagogical ideas. The first wave of teachers from Shanghai arrived at the beginning of November: a list of schools taking part in the first exchange is here. We hope to bring you some reflections on the exchange from some of these teachers in subsequent editions of the Primary Magazine.

Mastery

Part of the work being carried out through the Maths Hubs project is an exploration of the 'mastery' approach to teaching and learning mathematics, commonly used in south-east and east Asia. The Director for the NCETM, Charlie Stripp, comments on the use of differentiation in primary school maths in his most recent blog, in tandem with the publication of the NCETM's definition of mastery. Please contribute to the discussion about some of the points that Charlie has made, and let us know your thoughts about mastery and differentiation.

Parcels…

While you are preparing to send parcels this Christmas, you may be interested in this BBC news article about the need to think mathematically to make sure your parcels are sent using the cheapest postage, as the Royal Mail changes its pricing structure again.

NCETM National Curriculum support

Have you explored our National Curriculum Planning Tool yet? This interactive tool will support you in the following ways: your subject knowledge; making connections within and across the primary curriculum; suggest helpful papers, pupil activities, exemplification of expectations, and links to the suite of NCETM videos. There are also sections on the Bar Model, Teaching Fractions, Progression in Reasoning, and

Developing a Scheme of Work-all accessible via buttons on the main National Curriculum information page.

Mathematics CPD

Don't forget that if you are looking for high quality providers of maths CPD in the next academic year, use our Professional Development Directory to find CPD Standard Holders (gold rosette) or Accredited Professional Development Leads (purple rosette).

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New National Curriculum in Focus

New National Curriculum in Focus is dedicated to unpicking the new curriculum and how to understand and develop the requirements of the new programmes of study for mathematics

Fluency, Reasoning and Problem Solving in Geometry in Upper KS2

While there is a great emphasis on arithmetic in the new curriculum, the remaining programmes of study still retain an important feature of a broad and balanced curriculum. In this section we will explore some of the changes in the new National Curriculum for upper KS2 in Geometry, suggest how to refresh subject knowledge for this area of the curriculum, and provide some suggested activities.

Previously known as Shape and Space, this strand is now referred to as Geometry and is a term consistent across all Key Stages (including KS3). The new programme of study requires the following for Y5 and Y6:

Y5 - Properties of Shape

Pupils should be taught to:

- identify 3-D shapes, including cubes and other cuboids, from 2-D representations
- know angles are measured in degrees: estimate and compare acute, obtuse and reflex angles
- draw given angles, and measure them in degrees.
- identify:
    - angles at a point and one whole turn (total 360°)
    - angles at a point on a straight line and ½ a turn (total 180°)
    - other multiples of 90°
- use the properties of rectangles to deduce related facts and find missing lengths and angles
- distinguish between regular and irregular polygons based on reasoning about equal sides and angles.

Y5 – Position and Direction

Pupils should be taught to:

- identify, describe and represent the position of a shape following a reflection or translation, using the appropriate language, and know that the shape has not changed.

Y6 – Properties of Shape

Pupils should be taught to:

- draw 2-D shapes using given dimensions and angles
- recognise, describe and build simple 3-D shapes, including making nets
- compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons
- illustrate and name parts of circles, including radius, diameter and circumference and know that the diameter is twice the radius

- recognise angles where they meet at a point, are on a straight line, or are vertically opposite, and find missing angles.

Y6 – Position and Direction

Pupils should be taught to:

- describe positions on the full coordinate grid (all four quadrants)
- draw and translate simple shapes on the coordinate plane, and reflect them in the axes.

Subject Knowledge

Firstly KS2 teachers must be confident in their own geometric subject knowledge; not just for KS2 but also for KS1 and KS3 in order to understand how the subject progresses, and to ensure that the foundations that were laid in KS1 and lower KS2 enable a seamless journey through the geometry curriculum, and are not building any misconceptions that will cause difficulties later in KS3. The Self-evaluation Tools for Geometry in KS1, KS2 and KS3 are a useful way to monitor and develop teacher subject knowledge. This paper from the Nuffield Foundation captures some key issues in learning geometry in the primary years.

Activities for *Fluency, Reasoning, and Problem Solving* in Geometry in Upper KS2

Properties of Shapes

In order for pupils to be fluent in the properties of shapes they will need to become increasingly familiar with and confident in using accurate vocabulary. Below is a list of suggested key vocabulary to introduce across Y5 and Y6 and builds on the vocabulary introduced in KS1 and lower KS2 (see Issue 67 and Issue 68).

Degrees (°), angles at a point, angles on a straight line, regular, irregular, protractor, diagonal, nets, polygon, radius, diameter, circumference, vertically opposite angles, rhombus, parallelogram

A key aspect of teaching geometry well is to ensure that children see relationships between shapes of the same type (transformations) and between shapes of different types. For example being able to see shapes within shapes will help children to see that a parallelogram is in fact a rectangle with a triangle sliced off one end and replaced at the other end. This is important in being able to understand why the formula for finding the areas are the same.

Similarly, a rectangle is formed by two identical (congruent) triangles which explains why the area of the triangle is half of the parallelogram formed by the two triangles.

Where children have the opportunity to make these relationships for themselves they are more likely to gain conceptual understanding of the procedures for finding areas and later for finding similar triangles.

Encouraging pupils to pay attention to the properties of shapes will help them to generalise about different shape families but using good examples is key to ensuring that pupils fully understand the prerequisite properties. Providing examples that are 'very nearly' or 'only just' will help pupils to attend to these properties. In secondary schools, dynamic geometry software (DGS) is commonly used to explore these ideas. By Y5 or 6 pupils can easily begin to access this learning environment too and there are examples of research supporting the use of DGS in primary schools [e.g. see Sinclaire and Jones, 2009]. The teacher will need to have become familiar with the software/ environment before using this with

children. DGS provides the benefit of being able to construct and manipulate 2D shapes through 'dragging' features of the shape around the screen. This process reveals the 'invariant' and 'variant' properties of a shape. For example, by dragging a parallelogram's vertex the corresponding angles will vary accordingly however the parallel lines remain parallel. This is a powerful tool for discerning spatial relationships.

A free DGS environment called Geogebra is available to download, together with a manual for getting started; other commercial products are also available.

The Y5 and 6 programmes of study have a great emphasis on developing an understanding of angles in 2D shapes. Another computer environment in which to explore angles is with Logo. Logo is a simple computer programming language that will fit well with the new requirements for the new Computing programme of study as well. A version of Logo is available to download for free, together with a starter manual.

The National STEM Centre eLibrary has a pack of suggested tasks to use with pupils, but the beauty of Logo is that pupils will begin to explore their own ideas as they become more familiar with the environment.

Paper folding is a fun and interesting way of exploring angles. Folding A4 and square paper to make triangles and then opening them out again can reveal intersecting lines (where the paper was folded) which can be deduced from understanding angles in a triangle and in a straight line. See how to fold an equilateral or isoceles triangle.

This Pocket Protractor, which can be made through paper folding, shows the angles that can be found on a square piece of paper when folded into an isosceles triangle. Ask the children to deduce the angles created by the folds.

Position and Direction

In order for pupils to be fluent in describing position and direction they will need to become increasingly familiar with and confident in using accurate vocabulary. Below is a list of suggested key vocabulary to introduce in Y5 and Y6, and builds on the vocabulary introduced in KS1 and lower KS2 (see Issue 67 and Issue 68):

Origin, axes, positive, negative

The focus for Y5 and Y6 concentrates on geometrical shapes in all four quadrants on a 2D plane. Connections with properties of 2D shapes can be made on grids. A simple task of plotting four co-ordinates to reveal a quadrilateral can be adapted to develop pupils' spatial reasoning by asking pupils to find all squares on a 5 x 5 axes that as one vertex on the point (1,1) this can be extended by asking pupils to generalise the co-ordinates of the remaining vertices using algebraic notation. The NRICH activity, Ten Hidden Squares, involves pupils thinking more deeply about properties of shapes and translations and enlargements of squares. Pupils can also use the reflection of 2D shapes about the vertical or horizontal axes to explore the relationship between the co-ordinates in the reflection of a shape. Another NRICH activity, Coordinate Tan, will enable pupils to generalise about coordinates when the origin changes.

Further links:

NCETM National Curriculum Y5 Properties of Shape Activities

NCETM National Curriculum Y6 Properties of Shape Activities

NCETM National Curriculum Y5 Position and Direction

NCETM National Curriculum Y6 Position and Direction

NCETM Research Gateway Geometry in KS1 & 2

National STEM Centre eLibrary Y5 & 6 Geometry

NRICH Properties of Shape KS2

NRICH Position and Movement (KS2).

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Where's the Maths in That? – Maths across the curriculum

*In this section of this Primary Magazine we explore how mathematics can be embedded into other subjects in the context of the new curriculum. The subject in this new series is **science** and over the next few months we will explore the different themes for the KS1 and KS2 science programmes of study and how maths can be embedded in and enhance understanding of scientific ideas.*

The In this edition we look at the theme of **Light** for Y6 and how a scheme of work for this might incorporate mathematical skills.

The statutory requirements for **Light** in the Y6 programme of study are:

Pupils should be taught to:

- recognise that light appears to travel in straight lines
- use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye
- explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes
- use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them.

This theme will provide opportunities for plenty of mathematical work. Below are some ideas for incorporating maths into this science theme.

Building on the work done in year 3, provide pupils with a torch and a mirror. Place a sticky note or other target on a wall or ceiling and ask the pupils to shine the torch on the mirror so that the light reflected hits the target. Although pupils may find it hard to measure the angle of incidence and angle of reflection at this stage, they will be beginning to gain an understanding of this relationship. Pupils should be encouraged to use the vocabulary of angles to describe what they have done to the torch in order to get the reflected light beam to hit the target.

Ask pupils to investigate what happens to the length of a shadow as the light source changes position from the object casting the shadow. Pupils should take measurements of the shadow and distance of the light source from the object, using a suitable scale to assist them in plotting results on a line graph,

choosing their own scales for their axes, and using this to draw the conclusion that the further away the light source from the object, the shorter the shadow of the object becomes.

Explore how the eye can be tricked using optical illusions. This article from Issue 8 of the Primary Magazine describes how the work of the optical illusionist/artist, Maurits Cornelis Escher might be used to support mathematics.

Pupils can explore how to make different 2D shapes from 3D objects by shining a light source vertically above or directly behind an object. Ask pupils to consider the number of different 2D shapes that be found from different shapes. Explaining why the 2D shape shadow that is formed is the shape that it is. Using a cone with the circular face pointing upwards will cast the same shadow as when the face is pointing downwards. Encourage pupils to explain why this is. Ask pupils to suggest other 3D shapes that might produce this phenomenon.

Investigate eye colour of all the pupils in the class, presenting the results as a pie-chart.

Maths in the Staff Room – Short Professional Development Meetings

Last month we featured the first of two articles that looks at assessment in primary maths classrooms now that National Curriculum levels are no longer recommended for use. The second article will follow in a future edition. In the meantime, it may be helpful for teaching staff to remind themselves of the ever-present desire to use various assessment methods as a tool for learning.

One of the rich collection of Departmental Workshops – all designed to help teachers in schools collaborate in areas of professional learning - is centred on just that area.

It's called Effective AfL in Mathematics and it suggests a way to construct a staff meeting to look at the generic aspects of assessment for learning, and a few maths-specific ones as well.

It was first written a few years back, but the essential principles remain unchanged.

The Departmental Workshops collection lies within an area of the NCETM website that houses all the microsites (websites within websites) developed over the years. These cover a wide range of topics, including Lesson Study, High Attaining Pupils in Primary Schools, and the NCETM's Primary Mathematics Host Schools Project. Perhaps one or two of these might make a good starting point for a fruitful staff meeting.