Primary & Early Years Magazine 67

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 66 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 this 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 KS1*.

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 *Living Things and their Habitats for Y5*.

Finally, Maths in the Staff Room provides a simple plan for CPD meetings in your school to be led by a member of your staff. These are short meetings that can be used exactly as indicated, or adapted to meet the CPD needs of the school. Editable resources are supplied to enable flexibility of 'delivery'. In this edition we focus on *multiplication tables*.

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

New SEND Code of Practice
You might be aware of the new code of practice for pupils with special educational needs and disabilities which came into force on 1 September. But what does this mean in the context of provision for pupils' difficulties in mathematics? Nasen, in partnership with DfE, has developed a suite of support materials and CPD modules to assist schools in the implementation of the new code of practice. Much focuses on difficulties in reading, however there are some materials to support mathematics. With such a key message from the code as this: *"Every teacher is responsible and accountable for all pupils in their class wherever or with whoever the pupils are working with"* it is essential that every teacher including the SENCO understands potential difficulties in mathematics and teaching and learning strategies that can help pupils who are falling behind.

Below are some useful sites to explore this in more detail:

- NCETM SEN microsite
- Dyscalculia online CPD module (also available as a PDF)
- The SEND Gateway.

National Curriculum
Have you explored the NCETM 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).

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 KS1

Those 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 KS1 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 Y1 and Y2:

Y1 - Properties of shapes

Pupils should be taught to:

- recognise and name common 2-D and 3-D shapes, including:
- 2-D shapes [for example, rectangles (including squares), circles and triangles]
- 3-D shapes [for example, cuboids (including cubes), pyramids and spheres].

Y1 – Position and Direction

Pupils should be taught to:

- describe position, direction and movement, including whole, half, quarter and three-quarter turns.

Y2 – Properties of Shape

Pupils should be taught to:

- identify and describe the properties of 2-D shapes, including the number of sides and line symmetry in a vertical line
- identify and describe the properties of 3-D shapes, including the number of edges, vertices and faces
- identify 2-D shapes on the surface of 3-D shapes, [for example, a circle on a cylinder and a triangle on a pyramid]
- compare and sort common 2-D and 3-D shapes and everyday objects.

Y2 – Position and Direction

Pupils should be taught to:

- order and arrange combinations of mathematical objects in patterns and sequences
- use mathematical vocabulary to describe position, direction and movement, including movement

in a straight line and distinguishing between rotation as a turn and in terms of right angles for quarter, half and three-quarter turns (clockwise and anti-clockwise).

There are just a few differences compared to the old curriculum:

1. By the end of KS1 pupils are required only to identify a vertical line of symmetry in a 2D shape where previously the orientation of the line was not specified. However there is no reason why pupils should experience line symmetry with lines in other positions.
2. There is an increased expectation for understanding rotation through quarter, half and three-quarter turns which relate to the increased expectations for fractions. This also includes movements in a clockwise and anti-clockwise direction.
3. Finally there is no specification for the use and application of mathematics, but the aims of the new National Curriculum - fluency, reasoning and problem solving - should be integrated into the teaching and learning.

So how can this be achieved?

Subject Knowledge

Firstly KS1 teachers must be confident in their own geometric subject knowledge; not just for KS1 but also for KS2 in order to understand how the subject progresses, and to ensure that the foundations being laid in KS1 enable a seamless journey through the geometry curriculum, and are not building any misconceptions that will cause difficulties later in KS2. The Self-evaluation Tools for Geometry in KS1 and KS2 are a useful way to monitor and develop teacher subject knowledge.

Activities for Fluency, Reasoning, and Problem Solving in Geometry in KS1

Properties of Shapes

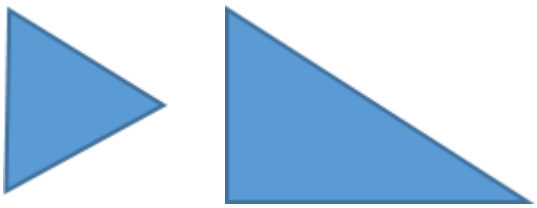
In order for pupils to be fluent in the properties of shapes they will need to become increasingly familiar with and confident in using accurate vocabulary. Below is a list of suggested key vocabulary to introduce and use through Y1 and Y2.

2D shape, 3D shape, rectangles, squares, triangles, circles, hexagons, pentagons, cube, cuboid, prism, sphere, cylinder, pyramid, side, edge, vertex (vertices), face, line, straight, curved, symmetry, large(r), long(er), tall(er), wide(r), thick(er), small(er), short(er), narrow(er), thin(ner), same, different.

Provide plenty of opportunities for pupils to compare shapes including different varieties of the same shape and in different orientations to develop pupils' vocabulary and geometric reasoning skills. The two activities below achieve this and are easily adaptable to many geometric situations:

Same and Different

What's the same? What's different about these two triangles?



Odd One Out

Which shape is the odd one out **and why**? (Challenge pupils to find as many different reasons for each shape as possible).

Play matching games where real life objects have to be matched to a modelled 3D shape. Or match shadows or prints of 3D shapes or objects. Offer pupils real life objects and draw round them; pupils have to identify the outlines on someone else's piece of work.

Construct 2D shapes using geoboards (peg boards). Elastic bands can also be used to define lines of symmetry to make symmetrical patterns. NRICH has a list of suggested activities and tasks to try out using geoboards (scroll through the features at the top) and pegboards.

Deepen pupils' understanding of the differences of 2D or 3D shapes by using different sorting diagrams, such as Venn Diagrams or Carroll Diagrams. Tree diagrams are particularly useful in getting pupils to distinguish properties of different shapes. Here is an example of a simple diagram to ask pupils to complete. All the sorting diagrams suggested, can be adapted to encourage deeper reasoning, such as leaving out the descriptions/ or questions, adding or removing a shape etc. not suggesting any shapes from the outset or asking pupils to create their own diagram from a limited set of shapes. There are also branching databases that many schools may already have in school which will have been used for ICT projects in KS2 (Y4) with the old curriculum. These are usually very accessible and some KS1 pupils may be able to use these.

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 and use through Y1 and Y2.

Left, right, top, middle, bottom, on top of, in front of, to the side, above, below, between, beside, around, near, close, far, up, down, forwards, backwards, towards, away, inside, outside, turn, clockwise, anti-clockwise, whole turn, half turn, quarter turn, three-quarter, directions, position, rotate.

Pupils need to develop an understanding of position and direction from their own and others' perspectives. Therefore lots of opportunities should be given for pupils to move themselves, in response to given directions and also give directions to others. This is particularly important when considering turning. The requirements for rotation in the programme of study closely relate to the expectations for telling the time and fractions. Pupils will need to have experienced the language of fractions (halves and quarters) in order to relate the different types of turns they are making and likewise have experienced this before learning about quarter past/quarter to in the context to reading an analogue clock.

Having experienced position and direction from an individual's perspective, pupils can then move on to relating position and direction of objects. Tangrams are an absorbing way to encourage pupils to reason about translations and rotations to make pictures from five or seven shapes. These resources provide a seven-piece tangram and accompanying pictures for pupils to make. Alternatively you can download this app for free, which particularly enables you to slide the pieces around and rotate the shapes in chunks of 45°.

Logic puzzles such as Coloured Squares from NRICH are also fun for pupils to solve and then try to write for themselves. Deepen pupils thinking and reasoning by challenging them to write the instructions in as few clues as possible. Here are some other activities for position and direction from NRICH.

Pupils love to send programmable toys around routes. This lovely project from the Nuffield Foundation using a roamer will combine design and technology (and 3D shapes) as well as learning about position and direction.

Further links

Research Gateway: Geometry in KS1 & 2

Professional Development Directory Geometry KS1

National STEM Centre eLibrary Shape and Space KS1

NRICH Shape (Stage 1).

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 **Living Things and Their Habitats** for Y5 and how a scheme of work for this might incorporate mathematical skills.

The statutory requirements for **Living Things and Their Habitats** in the Y5 programme of study are:

Pupils should be taught to:

- describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird
- describe the life process of reproduction in some plants and animals.

Below are some ideas for incorporating maths into this science theme

1: Describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird

Through research, ask pupils to create their own top trumps cards about the life cycles and environments of different types of creatures. E.g. gestation times of different mammals, incubation times for eggs; heights/lengths of the creatures at different stages of their life cycles and life spans. Pupils will need to determine what the units of measures they use in the data they are collecting. Use the cards to play top trumps.

2: Describe the simple physical properties of a variety of everyday materials

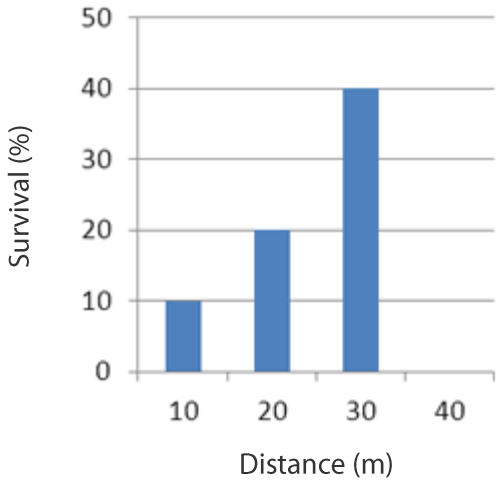
Design and carry out group investigations to identify conditions for germination. E.g. Using a set of three paper pots containing the same amount of compost, sow a sunflower seed at different levels in the pot, deep, middle and on the top. Water regularly with the same amount of water and leave in the same location. Pupils will be involved in a lot of accurate measuring in order to ensure that this test is fair. Other groups can also design

and carry out tests by varying a different condition, i.e. lots of water, no water and an amount in between. The pupils will need to agree how much water will need to be used to feed the plants and how frequently. A further variation can be with light. When the experiment is complete pupils should use the results to determine the optimal conditions for germination on the basis of the available data and use these to germinate another seed.

Using an area of the school field that can be left untouched (unmown) for an extended period and also has daisies growing, pupils will measure out and define a 50cm x 50cm quadrat to observe a daisy lifecycle over time. Pupils should keep a diary of dates and observations. If there is space, allow groups of children to define different quadrats in different locations to see if there is any variation in the time- scale for a daisy lifecycle because of the environment. Pupils can use this data to generate a mean period of time when different stages of the lifecycle occur.

Experiment with the shape of a helicopter seed based on the seed dispersal process of a sycamore tree. Use these cre8te maths resources from the National STEM Centre eLibrary. Pupils carry out a test with a paper model of a helicopter seed made from paper to determine the horizontal landing distance from the point of dropping. Pupils need to measure accurately and to collect data over ten tests to form an average (mean). This task can be done in groups. The group then change one variable such as wing length, tail length or mass, and repeat the experiment, collecting the data and comparing to the control data. This spreadsheet could be used by each group. An example for the mean formula has been inserted into cell L5. This could be left in, or ask pupils to create the formula for the cell.

Draw conclusions from bar charts that plot survival rate against distance from parent plant (i.e. in the example the further from the parent plant, the better the survival rate).



Discuss why this might be - i.e. food chain may be less well established further away from the parent plant.

Pupils might enjoy exploring a mathematical story to generate the Fibonacci sequence. The online resources below explain how the Fibonacci sequence can be generated using rabbits (best known) or cows and bees based on their reproductive process:

- Fibonacci's Rabbits
- Dudeney's cows
- Honeybees and Family trees.

Some of the ideas above have been adapted from resources on the Kew Gardens Great Plant Hunt website. Other useful resources to support your planning can be found in the National STEM Centre eLibrary.

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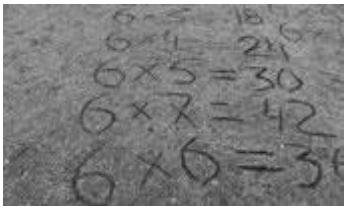

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Maths in the Staff Room – Short Professional Development Meetings

This section provides suggestions and resources for a professional development meeting for teachers that can be led by the maths subject leader or another person with responsibility for developing mathematics teaching and learning in the school

Recalling Multiplication Table Facts

Meeting Aims

- Ensure a consistent approach to the teaching of multiplication table facts from Y1 to Y6.

Timing

- 1.5 hours

Resources

- Counters/Cubes
- Video clip supporting slides
- From skip counting to recall of multiplication facts slide
- Progression Map: Multiplication and Division.

Introduction

Share the aim of the professional development meeting.

1. Ask teachers to each "write down the two-times table up to the fifth multiple" (make sure to ask them with these exact words) without sharing with anyone else. When they have written this down explain that they are now all going to read their multiplication table aloud, starting on the count of 3. Typically what happens at this point in many schools is that some teachers will read aloud "2 times 1 is 2, 2 times 2 is 4, 2 times 3 is 6…", others will read "once times 2 is 2, 2 times 2 is 4, 3 times 2 is 6…" and others will say "once 2 is 2, 2 2s are 4, 3 2s are 6". The point to be made if this happens is that the pupils are getting an inconsistent approach to reciting the times tables and therefore potentially leading to insecure recall and understanding. Alternatively you could ask teachers to video pupils from their classes before the staff meeting, saying a multiplication table. Watch the clips and compare to make the same point

Developing teachers' subject knowledge

2. Explain that fluent recall of multiplication table facts needs to be achieved along with a deep understanding of multiplication and that this is best achieved when concrete and visual representations are used to support learning.

Ask the teachers to discuss in small groups (pairs or threes) the concrete and/or visual representations they would use for 3x4 and record these on an A3 sheet of paper.

Compare the representations on the sheets and discuss similarities and differences in the representations. In particular focus on whether there are different interpretations for 3 x 4. i.e. are teachers representing 3 x 4 as "three lots of four (4 + 4 + 4)" or "three, four times (3 + 3 + 3 + 3)?

Strictly (mathematically) speaking 3 x 4 means 3 + 3 + 3 + 3 but many primary schools read 3 x 4 as "three lots of 4". Clearly because multiplication is commutative both generate the same answer but it is important that whichever interpretation is used, it is consistent throughout the school to avoid pupils becoming confused.

3. Watch this NCETM video clip of a KS1 teacher using multiple representations for multiplication. (This teacher works in a school where 3 x 4 is interpreted as 3 + 3 + 3 + 3). Use this set of slides to support how you can use this video clip to lead discussions about supporting conceptual understanding alongside fluency.

Share evidence for the importance of fluency in multiplication tables

4. Ofsted (2011) - Good practice in primary mathematics: evidence from 20 successful schools

Key finding:

Understanding … and good recall of number facts such as multiplication tables … are considered by the schools to be essential precursors for learning traditional vertical algorithms(methods) for … multiplication and division. (p6)

Other findings:

Lack of fluency with multiplication tables is a significant impediment to fluency with multiplication and division. Many low-attaining secondary pupils struggle with instant recall of tables and often resort to finding specific products such as 6 x 4 by counting up in the required multiple (4, 8, 12, 16, 20, 24), sometimes even counting on their fingers from one term to the next.

Ask teachers to reflect on how prominent times tables are in their classrooms and to what extent pupils are moved beyond skip counting (i.e. saying "2, 4, 6, 8, …") to instant recall of facts.

Prompting Question:

- How do you say multiplication tables in your class?
- How often are multiplication tables and facts practised in your class?
- Is the value of multiplication tables consistently shared across the whole school? If so, how? If not, why?

Developing Practice

5. Use this slide to model how to build fluency with multiplication table facts. Explain that some or all of the steps can be used with pupils in any one teaching episode. Teachers could change/ vary the representation they use.

Embedding in Practice

6. Ask teachers to look at the Multiplication and Division Facts section of the Progression Map.

Ask teachers to discuss what each year group will need to focus on to ensure that pupils master the expectation in Y4. i.e. is it possible that Y1 pupils could know by heart all their multiplication facts up to 5 x 5 supported by concrete and visual representations? (There are just 9 facts to learn if pupils know that, for example 3 x 4 = 4 x 3 and that the x1 table is easy!).

Take time to establish the following school issues to ensure consistency:

- How 3 x 4 (etc) will be interpreted.
- How the multiplication tables will be said aloud.
- What representations will be used (e.g. arrays) across all year groups to ensure consistency?

Further links

Self-evaluation

- KS1 Self-evaluation Tool (the four operations)
- KS2 Self-evaluation Tool

Research Gateway

- Multiplication Tables

NCETM Professional Development Calendar

- Multiplication

Other helpful links

- What does it mean to know your tables
- Coded Tables
- Gill Mansergh teaches the 17 times table in ten minutes
- Mathematics Teaching; Sep 2000, Issue 172, p36 (you may need to be an ATM member to access this article online).