Primary & Early Years Magazine 73

National Centre for Excellence in the Teaching of Mathematics

Welcome to another issue of our new-look and more compact Primary Magazine. This magazine has been serving primary practitioners for 73 issues 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 issue 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. This issue focuses on fluency, reasoning and problem solving in Statistics in 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 *Earth and Space* for Y2.

Finally, Maths in the Staff Room provides simple plans for CPD meetings in your school to be led by a member of staff. These are short meetings that can be used exactly as indicated or adapted to meet the CPD needs of the school. In this issue we explore outstanding mathematics teaching.

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

Shanghai teachers

A second wave of teachers from Shanghai has arrived to teach in primary classrooms across England as part of the Maths Hubs programme. They will be here for most of the month of March, teaching in 25 different schools in 17 Maths Hub areas.

Carter Review

In January the DfE published the Carter Review of Initial Teacher Training. This is not a maths specific document but will influence DfE policy on the ITT of all primary teachers. The DfE response to the review sets out some policy decisions to realise some of the recommendations of the review. Of note is the formation of an expert working group to decide the content of the core framework. Maths features as a priority for subject-knowledge enhancement programmes for primary teacher building on existing programmes that have been already been supported by the National College for Teaching and Leadership (NCTL), and in partnership with stakeholders such as the Maths Hubs.

Parliamentary Group's views on maths in pre-school

The All Party Parliamentary Group for Maths and Numeracy recently convened an expert group to discuss how maths and numeracy is learnt in pre-school settings and how a positive attitude can be instilled during this vital stage of learning. One recommendation suggests that maths should move to being a prime area of development, and in tune with the Carter Review recommendations for primary (and secondary teachers), all early years practitioners, both new entrants and the existing workforce, should be trained in children's mathematical development.

Conferences

It's conference season again. Have you booked yet for any of the subject associations' spring/ Easter conferences?

- ATM Conference: Thinking Mathematically (30 March - 2 April, Staverton Park Conference Centre, Daventry)
- MA Conference: Fluency and Understanding - A Mathematically Balanced World (8 - 10 April, Keele University).

London Mathematical Society CPD Grants

Did you know that the London Mathematics Society (LMS) provides opportunities for schools/ teachers to bid for grants of up to £400 to support teachers with maths-specific CPD? There are certain conditions that need to be met and application deadlines for grants are 31 August, 30 November, 31 January and 30 April each year. These grants are available for all teachers.

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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National Centre for Excellence in the Teaching of Mathematics

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. You can find previous features in this series here.

Fluency, Reasoning and Problem Solving in Statistics in 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 suggestions for activities in the new National Curriculum for KS2 in Statistics; suggest how to refresh subject knowledge for this area of the curriculum, and provide some suggested activities.

The new programme of study requires the following for KS2:

Pupils should be taught to:

Y3

- interpret and present data using bar charts, pictograms and tables
- solve one-step and two-step questions (for example, 'How many more?' and 'How many fewer?') using information presented in scaled bar charts and pictograms and tables

Y4

- interpret and present discrete and continuous data using appropriate graphical methods, including bar charts and time graphs
- solve comparison, sum and difference problems using information presented in bar charts, pictograms, tables and other graphs

Y5

- solve comparison, sum and difference problems using information presented in a line graph
- complete, read and interpret information in tables, including timetables

Y6

- interpret and construct pie charts and line graphs and use these to solve problems
- calculate and interpret the mean as an average.

Subject Knowledge

The KS2 programme of study mentions the use of discrete and continuous data. In the KS1 programme of study pupils will have explored categorical data i.e. data that can be sorted into groups and then counted. As pupils progress through KS2 they will need to be able to discern between discrete and continuous data so they can interpret and present such data accurately and appropriately.

Discrete data results from situations involving discrete variables e.g. the number of coins in pupils' pockets; number of peas in a pod, or, number of whole lengths swum in a sponsored swim. Discrete data may be grouped. Example: Having collected the shoe sizes of pupils in the school, the data might be grouped into 'number of pupils with shoe sizes 3 – 5, 6 – 8, 9 – 11', etc. Discrete data can be recorded on a block graph, bar chart or pie-chart (once the numbers have been converted to a proportion of the whole data set). When presenting using a bar chart, there should be gaps between the bars to show that data is discrete.

Continuous data arises from measurements taken on a continuous variable (examples: lengths of caterpillars; weight of crisp packets). Continuous data may be grouped into touching but non-overlapping categories (for example, height of pupils [x cm] can be grouped into $130 \leq x < 140$; $140 \leq x < 150$ etc. where, importantly, the value 140cm is clearly in one category and not the other). Continuous data might be presented using a histogram or a line graph depending on whether the data is grouped or not.

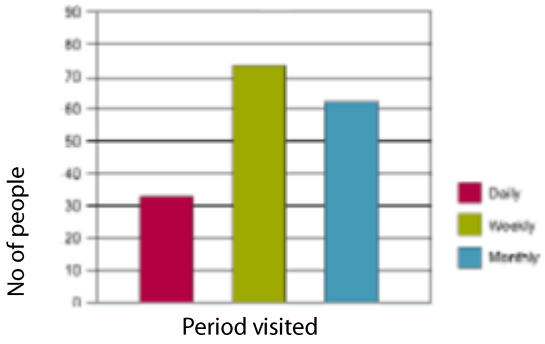
As pupils become more familiar with different representations of data they will need to be able to apply their number skills to estimating from and interpreting axes in different scales.

Bar charts

A bar chart is a format for representing statistical information. Bars, of equal width, represent frequencies and the lengths of the bars are proportional to the frequencies (and often equal to the frequencies). A bar chart is sometimes called bar graph. The bars may be vertical or horizontal depending on the orientation of the chart. Data may first be collected on a frequency table and then transferred to a bar chart to help make the data clearer.

Frequency of visit	Number of people
Daily	31
Weekly	72
Monthly	61

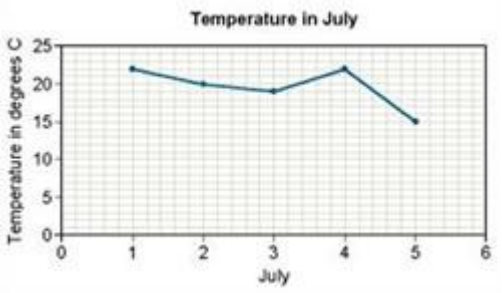
Frequency of people visiting a museum



Time graphs

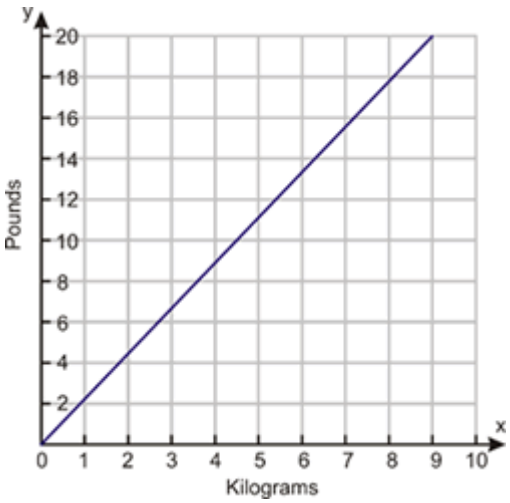
Time graphs present data that have been collected at certain time intervals. Time is usually plotted along the x-axis (horizontally) against another measured event. E.g. the growth of a plant in cm on a weekly basis, the temperature of a classroom each hour of the day etc. Each measurement on a time graph is plotted with a point on a graph and the points are then joined with a line. Any point along the line

provides further approximate measurements between the time intervals when the measurements were taken. E.g in the table below. The temperature was taken in the same place at the same time on each day. The lines joining the data points provide an indication as to whether the temperature rose or dropped from one day to the next, however the intermediate points on the line may not be accurate as it might have been that the temperature rose and dropped between each point.



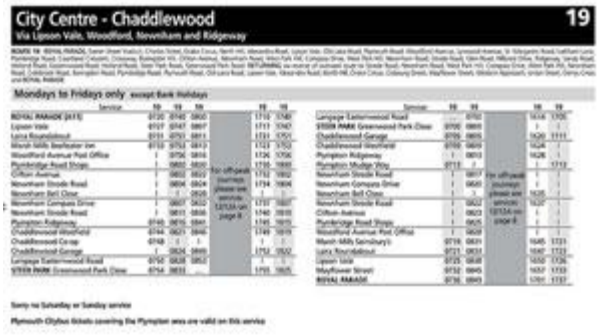
Conversion graphs

Conversion graphs are linear graphs that can be used to convert from one unit of measure to another. E.g. kilograms to pounds or kilometres to miles. Unlike time graphs, the data at any point along the line provides an accurate reading.



Timetables

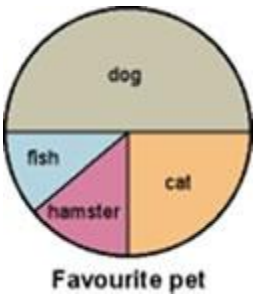
Timetables are a complex arrangement of data that require an understanding of conventions to interpret accurately. A common difficulty is understanding that journeys are plotted in a vertical direction when we in reality travel horizontally. Timetables are used to find out departure and arrival times and therefore journey durations can be calculated by reading times in the vertical arrangements and frequency of journeys by reading times horizontally.



Pie charts

A pie chart (or pie graph) shows the proportions of different categories of discrete data. A pie chart is a circle divided into sectors. The whole circle represents all the data. Each sector represents the number of items in that category of data.

This pie chart shows that a dog is the favourite pet of half the people asked and that a cat is the favourite pet of a quarter of them.



The 'pie' is the amount of space that must be shared between all people/things in the survey that are to be shown. So each pie has 360° to be shared between all of the group.

For example, if there are 90 people in the survey then each person will be 'worth' 4° (you get this amount by sharing the 360 between 90 people 360 ÷ 90 = 4).

It is possible for the number of people in the group to be more than 360. For example if there are 720 people that have been surveyed you still need to share the 360° between the 720 people 360 ÷ 720 = 0.5. So in this case each person in the survey will have 0.5° in the pie.

Pie charts are useful to interpret when the number of discrete categories is not too many or where lots of categories are of similar proportion.

Pie charts are a meaningful way of connecting pupils' understanding of fractions, angles in a circle, percentages and proportion and as such deep understanding of how they are created and interpreted can be challenging to achieve unless there is security in each of the those aspects of mathematics.

- NCETM Self-evaluation Tool: Statistics KS2.

Activities for *Fluency, Reasoning, and Problem Solving* in Statistics in KS2

In order for pupils to be fluent in manipulating and interpreting data 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 KS2 (this builds on the vocabulary for KS1)

> *Axis/axes, scale, discrete, continuous, bar chart, frequency table, data, survey, mean, database, line graph, timetable, time graph*

By the time children are in KS2 they will have begun to be familiar with some ways of representing and interpreting data (see Issue 72 for ideas for KS1). In KS2, children will need to become more systematic about managing data. As mentioned in the KS1 Statistics feature children need to be working with meaningful data in purposeful situations and begin to work more independently on larger data projects. A process for handling data in a project might be considered through these steps:

- Identify a problem/situation
- Make a hypothesis about the situation
- Design a data collection method that is fair and not biased
- Collect the data
- Display the data appropriately
- Analyse the data
- Say if your hypothesis is true or false and give reasons (using your presentation and analysis of the data you found
- Evaluate your project and say how you might do it differently next time.

Data projects can be used to teach new skills/concepts, to consolidate or to assess learning. There are a numerous examples of projects that pupils might engage in. Below are some examples.

Healthy Food Tuck Shop

This is a week-long cross-curricular project where pupils can work in teams of 5 or 6 in an 'Apprentice'-style challenge, the aim being to create the most profitable healthy tuck shop. The school fund could be used to provide a float for each team (to be paid back out of turnover). A suggested sequence of activities could be:

- Design a survey to ask pupils in the school/ other classes for favourite fruits and smoothies
- Present survey data to tell each tuck shop business what they should sell
- Collect data about prices of stock to sell
- Interpret data and decide on prices to resell stock
- Manage information about stock that has been sold to work out turnover and profit
- Evaluate the usefulness of the data collected in making a successful business.

Everyone Counts

Everyone Counts is a resource available through Oxfam which focuses on inequality. There are a number of projects within this suite of resources. The Mathematical Association (MA) has collaborated with Oxfam to create materials that focus on using data on inequality. This plan for a unit of work provides a detailed overview. Each session is supported with slides and PDF resources available from the Oxfam website:

> Session 1: How Can we Measure Wellbeing?

Session 2: Presenting Time Use Data
Session 3: Calculating Mean Time Use
Session 4: Comparing Time Use
Session 5: How do your Travel to School?
Session 6: Line Graphs

If the World Were a Village

This NRICH activity is based around the book 'If the World Were a Village' by David J Smith and Shelagh Armstrong (published by A&C Black, ISBN 978-0-7136-6880-3) using meaningful data about how different people's lives are around the world and how to represent the data relating to the world population 6 660 000 000 in a world 'village' of 100 people. The Office for National Statistics provided a range of real data for schools to use and this can now be found on the National Archives website.

Using reasoning to understand representations of data

Whilst extended projects are engaging and fun, there will also need to be opportunities to focus in on particular skills to learn how to construct or interpret representations of data. Starting with given data can be helpful so that everyone is working on the same numbers or representations so that skills can be honed collectively. The following approaches can used to ensure that pupils have a deep understanding of the representations of the data.

- Present the same data in different ways and evaluate what is the same and different about the representations?
- Present the data simultaneously with different representations (this can be done in spreadsheet software that can convert data to a variety of representations) but change one piece of the data to observe how the representations change or stay the same. This can be particularly good for noticing how spreadsheet software will automatically change the scale on an axis because the data has changed.
- Match tables of data to graphical representations.
- Provide multiple representations of data but with missing data or labels/ legends. Discuss how to compare the representations so that they all contain identical information.
- Read a familiar story that involves a journey from a fixed location i.e. the Three Little Pigs, Red Riding Hood, The Hare and the Tortoise and consider the time/ distance graph to represent the journeys. (This resource from the TES Community provides further examples of activities around this Hare and the Tortoise cartoon)
- When confident with generating time graphs, start with a time graph and provide a narrative for a time graph.

Further links:

- National STEM Centre eLibrary: Y3 & 4 Statistics
- National STEM Centre eLibrary: Y5 & 6 Statistics
- BEAM: Data handling for Lower KS2 (1)
- BEAM: Data handling for Lower KS2 (2)
- BEAM: Data handling for Upper KS2 (1)
- BEAM: Data handling for Upper KS2 (2)
- NRICH: Statistics KS2.

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. You can find previous features in this series here.*

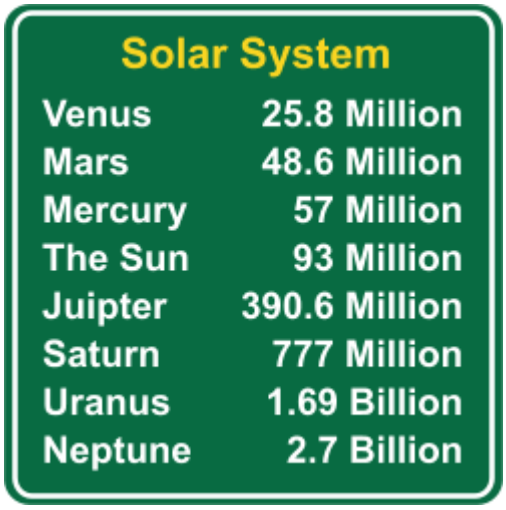
In this edition we look at the theme of **Earth and Space** for Y5 and how a scheme of work for this might incorporate mathematical skills.

The statutory requirements are that children are taught to:

- describe the movement of the Earth, and other planets, relative to the Sun in the solar system
- describe the movement of the Moon relative to the Earth
- describe the Sun, Earth and Moon as approximately spherical bodies
- use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky.

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

- Comparing the relative sizes of planets or planets with the sun or our moon using the interactive Planet Size website will provide opportunities to read large numbers and also to explore ratios. Pupils can record the ratios and then find other things in the same ratio. i.e. if an orange is Mercury how big would the sun be? What real life object could be the sun? Pupils can explore using a calculator to perform these scaling activities.
- This resource from the Institute of Physics provides a sequence of tasks to help understand the speed of light and by relating it to the speed one can travel on a motorway (70 mph) and then comparing it to how long it would take to reach astral bodies. Some pupils might be able to calculate, using a calculator, how long it would take to get to different planets if you were to travel at (an average of) 70 mph (were the technology available to do this) using this planet superhighway sign:



- The Your Weight in Space activity on the NASA Solar System website (under the 'Games' tab) is an interesting tool that converts your weight on other planets. Pupils could calculate the difference or find equivalent objects that weigh the same amount.
- Understanding how day and night arise involves lots of mathematical ideas. Pupils could calculate daylight hours from sunrise and sunset times in their locality and then compare to another country that they are familiar with using the international table.
- Pupils could use a month at a view calendar to plot the phases of the moon using data from the Time and Date website, which has lots of other data related to this theme - such as the world clock
- Sundials are also interesting to explore to illustrate the movement of Earth relative to the sun. This set of resources from the National Maritime Museum will provide ideas for pupils to make their own sundial. This online resource from the Liverpool World Museum includes a sun tracker that simulates the apparent path of the sun from a location of choice on a date of choice to observe how the apparent path varies at different times of the year, with a moving clock.

Suggested Link

- National STEM Centre eLibrary: Y5 Earth and Space.

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. You can find previous features in this series here.

Outstanding Mathematics Teaching

Meeting Aims

Explore what high quality mathematics teaching might look like in day to day practice in the light of recent research findings. Based on recent reports from the following:

- Exploring Effective Pedagogy in Primary Schools: Evidence from Research
- What Makes Great Teaching.

Timing

- 1.0 hours

Resources

- Executive summary EPPSE
- Executive summary Sutton Trust.

It would be helpful if the teachers have read the two executive summaries for the EPPSE and Sutton Trust reports prior to the meeting to make sense of the themes that have been used as a focus below.

1. Share the aim of the session

2. Understanding the mathematical properties of different representations

Begin by working through the following 6 statements as a self-auditing tool. Invite teachers to work in groups if in a large school or as a whole team if there are 6 or fewer teachers. Ask teachers to grade the statements based on their confidence from a whole school perspective. 1 = confidently agree; 2 = partially agree; 3 = disagree. (10 mins)

- Every teacher has 'great' **subject content and pedagogical knowledge**? We have a suitable System of support for teachers who would like to develop their subject knowledge to improve teaching.
- **Organisation**: We know which maths resources we have and how they can be best used to enhance teaching and learning in maths? A significant majority of pupils are independent/ self reliant in tackling mathematical problem solving? We promote independence/independent thinking in our maths lessons?
- We **share intended learning outcomes** with children for maths. We share learning outcomes when we want children to 'come to discover' a mathematical concept for themselves.
- All maths **homework** is meaningful to mathematical learning. Homework extends and deepens children's mathematical learning or improves fluency. Maths homework is used to inform planning and teaching. Pupils and parents know how well homework has been completed.

- The **climate** in every classroom enables children to challenge their own and each other's learning and the teacher's teaching in a non-judgemental way? Mathematical dialogue encourages mathematical justification between pupils and teachers. Effort and perseverance are a valued feature of teaching and learning in all maths lessons? Contributions from everyone in mathematics lessons are encouraged and equally valued by pupils and teachers?
- The **quality of 'instruction'** is of a high standard? Dialogic teaching is a feature of all maths lessons. Teachers plan for and use a range of question types during maths lessons. Strategies are used by teachers to encourage collaborative learning in maths. Copying can be seen as 'looking for insight' during lessons. Children play strategy games in maths lessons regularly; talk partners are used regularly; peer marking is used to improve and evaluate learning.

Feedback the scores that the teachers have given to each of the statements. Work through each of the six areas (or choose how to prioritise – i.e. the focus with the lowest score or the focus with a variation in perception). Unpick the feature and ask teachers to share maths specific examples of what they consider to be 'great' practice and why.

3. Conclusion and Reflection

Consider which of the features might need further attention at a future development meeting.

Future editions of Maths in the Staff Room *will address how to develop each of the six themes above.*