Primary Magazine
Issue 41

National Centre for Excellence in the Teaching of Mathematics

Welcome to the 41st issue of the Primary Magazine. In this issue we feature the artist Giotto di Bondone. We look at the mathematical possibilities of the topic 'Britain since 1945'. Focus on… features rainwater, and Maths to share explores the latest Ofsted report.

Contents

Editor's extras

The latest Ofsted report, Mathematics: made to measure, has recently been published. It is based mostly on evidence from inspections of mathematics between January 2008 and July 2011 in maintained schools in England. It draws attention to serious inequalities in pupils' experiences and achievements. It includes examples of best practice that help avoid or overcome the inequalities and weaker practice that exacerbates them.

The report builds on the inspection findings and case studies of 'prime practice' and 'weaker factors' of the 2008 report, Mathematics: understanding the score. It is also informed by the evidence underpinning the report Good practice in primary mathematics, published in 2011.

It seems to have been well received by the mathematics community and is well worth a read! Why don't you let us know what you think?

We explore its contents further in Maths to share.

As part of our new remit, we are offering a programme of mathematics professional development to support teaching schools and other improvement partners (those who provide professional development) in their work with schools, colleges and teachers.

This programme offers a series of free face-to-face events for CPD leads in teaching schools and improvement agents to work together to develop their roles as providers of professional development. There are 20 places available at each event.

By completing the programme, you will be:

- accredited by the NCETM to provide professional development in priority areas (arithmetical proficiency in primary schools/ algebraic and geometric proficiency in secondary schools and colleges)
- supported to obtain the NCETM CPD Standard - a nationally established, widely recognised and quality assured badge of excellence in CPD provision.

Our first event was in May of this year and it was very well received. If you are interested in coming along to any future events, you can find full details on our news page.

Following the successful regional projects funded by the NCETM, we are delighted to announce that we are offering funding for Collaborative Teacher Projects. Funding of up to £5 000 will be awarded to teachers to work collaboratively on projects that focus on mathematical proficiency, with a particular focus on arithmetic proficiency:

> **Mathematical proficiency** requires a focus on core knowledge and procedural fluency so that pupils can carry out mathematical procedures flexibly, accurately, consistently, efficiently, and appropriately. Procedures and understanding are developed in tandem

Arithmetic proficiency is the appreciation and sense of number and number operations that enable mental calculations and written procedures to be performed efficiently, fluently and accurately.

Priority will be given to projects which involve one or more schools where mathematical attainment is below national average, or where other evidence can be provided of the need to improve mathematical attainment.

Schools, teachers or an 'improvement agent' may lead the application, but the project needs to involve more than one school.

More information - including details of the application process and a downloadable application form - can be found on the Collaborative Teacher Projects page.

During the next few issues of the Primary Magazine we will be featuring some articles written by Steven Pratchett.

Steven was Senior Lecturer in Art & Design and Geography on undergraduate B.Ed and postgraduate programmes at the University College Plymouth, St Mark & St John from 1986 to 2009. He was involved in school-based research and curriculum development, which led to approximately 50 various published articles on the subjects of primary art & design, geography, mathematics and Education for Sustainable Development in professional journals, magazines, websites, including:

Primary Geographer (Geographical Association)
Teaching Geography (Geographical Association)
START, The Magazine for teachers of Pre-school and Primary Art Craft & Design (National Society for Education in Art & Design (NSEAD))
NCETM Primary Magazine
Mapping News (Ordnance Survey)
OSIER website
ESCALATE website
Plymouth University website
QCA website (now closed down).

He was also involved in several funded research projects. Our Focus on... article *What Happens to Rainwater?* was in collaboration with the National Council for Educational Technology (NCET), and explored how Excel spreadsheets could be used with primary children to support geographical enquiry.

Interestingly, he always hated mathematics as a child. His father was a secondary mathematics teacher but he never inherited the genes! His father was very talented at mathematics and, as well as being a bomber pilot during the War, worked on the Enigma computer and taught navigation to pilots in Canada. He began to enjoy mathematics early on in his primary teaching career when he taught mathematics using the Fletcher Mathematics Scheme. This taught him to understand mathematics, whereas his own education had been about learning computations by rote.

Steven is now retired but gets involved with university work now and again. Mostly he spends his retirement travelling, scuba diving and working on his hobbies of oil painting and underwater photography.

Does he miss education?
"...well, the teaching bit and interaction with students yes but the workloads, stress, politics, paperwork and lack of work-life balance no! So I am making up for it by my own personal development in retirement."

If you:

- have an article that you would like to submit
- have done something in school that you would like to share with us
- have a request for an artist or period of history you would like us to cover

...please let us know!

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The Art of Mathematics
Giotto di Bondone (c1267 – 8 January 1337)

Giotto di Bondone, known simply as Giotto, is considered by some to be the second greatest artist of all time after Pablo Picasso. One reason for this is that he was the first artist to add emotion to his work. He is also generally considered the first in a line of great artists who contributed to the Italian Renaissance.

Little is known about his life. The accuracy of the details of his birth date, appearance, apprenticeship, the works he created and the order in which he created them, as well as where he was eventually buried after his death are all uncertain. It was originally thought that Giotto was born in a hilltop farmhouse in Romagnano, Italy. Recent research suggests that he was born in Florence and was the son of a blacksmith. It is believed that when he was young he was a shepherd boy. It was while he was looking after his sheep that the painter Cimabue discovered him drawing pictures of them on a rock. These were so lifelike that Cimabue took Giotto on as an apprentice.

There are various stories about Giotto's artistic ability. Here is one of them: when Cimabue was absent from his workshop, his young apprentice Giotto painted such a lifelike fly on the face of the painting that Cimabue was working on, that, when he returned to his painting, he tried several times to brush it off!

He died in Florence in January, 1337 and was thought to have been buried in the cathedral there with great civic honours.

Between 1329 and 1332, he worked for the King of Naples. In 1334 he was appointed chief architect for the Cathedral of Florence, which he helped design and for which he created several statues. During his life he worked in Rome, Milan, Padua, Assisi, Ravenna, Rimini, other cities in Italy and also in France.

Giotto's most important work is the decoration of the Scrovegni Chapel in Padua, often called the Arena Chapel, which he completed in 1305. It is a *fresco* style of art and depicts the life of the Virgin Mary and the life of Christ. It is commonly thought to be one of the supreme masterpieces of the Early Renaissance.

Other famous works attributed to him include the Bardi and Peruzzi Chapel frescoes in Santa Croce, Florence, and the Ognissanti Madonna (Enthroned Madonna) for the Church of All Saints. A fresco is a mural painting executed on plaster walls, ceilings or any other type of flat surface. The word fresco comes from the Italian word 'affresco' which comes from the Latin word meaning 'fresh'.

Other works that have been accepted as Giotto's by some artists have been disputed by others. The controversy over which works are his has raged for over a century and has yet to be resolved.

Giotto focussed on presenting human figures and their actions realistically on a flat surface that represented three-dimensional space. Before Giotto, artists created flat forms and disregarded what they saw around them. Giotto studied both nature and the human body. This enabled him to create lifelike works which demonstrated dignity, emotion and humanity. He placed his human figures in free space. His genius was recognised and accepted immediately, so much so that the old forms of art gradually vanished, first from Florence and then from other parts of Italy. They were replaced by art forms in a similar style to Giotto's. His form, content, and freedom of expression had a profound influence on the subsequent development of European painting.

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Ideas for some Giotto-style mathematics!

Estimating and counting

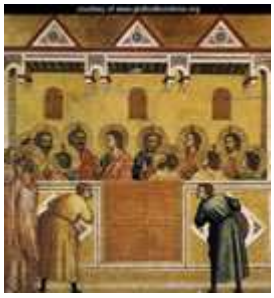
Show Last Judgement (detail 2) 1306, from the work Giotto did at the Scrovegni Chapel. You could use this as an opportunity to practice estimating and counting. How many faces do the children think there are? How could they count to check? Can they see any arrays? How might these help them? You could repeat this for Last Judgement (detail 3) and compare the number of faces.

Ratio

Show the Ognissanti Madonna. Discuss the colours that Giotto would have needed to paint it. You could talk about mixing different colours of paint to make other colours. This could lead naturally into the idea of mixing different ratios. You could give the children the opportunity to practice colour mixing, e.g. red and yellow to make orange. They mix using different ratios, e.g. one spoon of red for every two spoons of yellow. When the children have made a variety of different shades of a colour ask them to order them lightest to darkest shade. Invite other children to estimate the ratios of paints to make each.

You could then ask the children to mix paints to match up with those in Giotto's painting. They could make a note of the ratios of the different colours they made.

Scaling



You could use a copy of Pentecost to do some work on scaling up. Print out a copy of this painting and divide it into small rectangles, possibly 30 (six by five). Cut these out and give one to each child. They measure each side and create a rectangle that is five times larger than the piece they have. They then recreate their portion of the painting so that it is five times larger and draw it in their rectangle. You then put all the pieces together to create a very large Giotto! The scaling ratio is a suggestion, why not experiment with others? You could also scale down by, say, half, quarter or a third.

Frescoes

You could explore other Giotto paintings from The Complete Works and invite groups of children to make up their own fresco picture that uses Giotto-style figures.

Why not make up some of your own mathematics activities from Giotto's works of art? We would love to share any that you develop with other readers so please let us know.

Information sources

- Giotto di Bondone - The Complete Works
- Italia Mia
- Wikipedia.

Image Credits

Page Header - Statue of Giotto, photograph by Frieda, courtesy of Wikimedia Commons; Giotto detail of a painting by Paolo Uccello, courtesy of About.com Medieval History in the public domain; Last Judgement (detail), Ognissanti Madonna and Pentecost paintings by Giotto. Images courtesy of http://www.giottodibondone.org/ some rights reserved

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Focus on…Rainwater

What happens to rainwater when it reaches the ground?

In this issue's *Focus on…* we describe a funded project led by Steve Pratchett, in collaboration with the National Council for Educational Technology (NCET).

Steve's report gives some great ideas for cross-curricular mathematics including using and applying through investigative fieldwork and data handling during the investigation itself and for displaying results using Excel spreadsheets, back in the classroom.

The children involved in the project were a Year 5 class at Compton C of E Primary School, in an urban area of Plymouth. They were exploring the theme of water: this included their own personal water consumption, water in the developing world, water quality and associated health risks. As part of the project there were opportunities for field work which took place in Dartmoor National Park where they were able to investigate water in the rivers and streams of this nearby, contrasting locality.

> *"The argument for fieldwork has been dramatically strengthened in the past few years by neurological studies of the brain. We learn best, it seems, from rich, multi-sensory environments that provide a range of messages and meanings. Our brains are particularly good at extracting patterns from real life situations where information comes in a variety of modes and there is immediate feedback."*
> (Scoffam 2000 p.17)

> *"Fieldwork offers the opportunity for interesting and innovative teaching and learning; we need to make the most of it to bring a real practical dimension to our pupils' geographical experience. We should remember that, for many children, a fieldwork visit may be one of the most exciting and memorable events of their lives."*
> Chambers & Donert (1996 p.14)

In this article, we give you a taster of the possible mathematical work within this theme, particularly focussing on ICT. We have provided the full report as a PDF document so that you can explore it in depth if you wish.

One of the tasks the children were set was to explore the drainage capability of different soils. This was stimulated by an initial field trip which generated these questions:

- why are there bogs on Dartmoor?
- what types of plants colonise these wet and boggy habitats and why?
- why is the stream and river water on Dartmoor brown?

To help the children to explore these questions, Steve planned a programme of practical investigations which focused on the central question:

'What happens to rainwater when it reaches the ground?'

The project took place during the summer term which, unusually for Devon, was extremely hot and dry with not a drop of rain! So he found other ways of simulating rain. One was to run around the school

grounds with watering cans and observe how this artificial rain behaved as it fell on different surfaces, e.g. grass, bare soil, tarmac. By doing this, children were able to observe and record what happens to the water. Does it stay on the surface? Does it run off or soak away? How quickly does it disappear?

The children worked in mixed ability groups of four to carry out their investigations. They were given large sweet jars and egg cups for measuring amounts of water into their watering cans. They used buckets containing different surface types with drainage holes at their bases into which to pour the water. Each group made a scale on the sweet jar using their egg cup filled with water. Each time it was tipped into the sweet jar the level was marked on the outside with an OHP pen. This gave the children an opportunity to reinforce measuring in millilitres. Each sweet jar held about 80 egg cups full of water. When emptied into the watering can, this became the 'known amount of rainfall' to land on the soil. The markings on the jar enabled the children to read the water drained off in two ways:

1. the total amount drained through by the end of the experiment;
2. the amount drained through during timed intervals.

The children had to organise themselves in allocating the tasks required for carrying out the experiments, e.g.:

- the 'rainmaking';
- timing the 'rainfall' and calling out 30-second intervals;
- observing and calling out the level of water that had drained into the sweet jar at 30-second intervals;
- recording the data on a table of results.

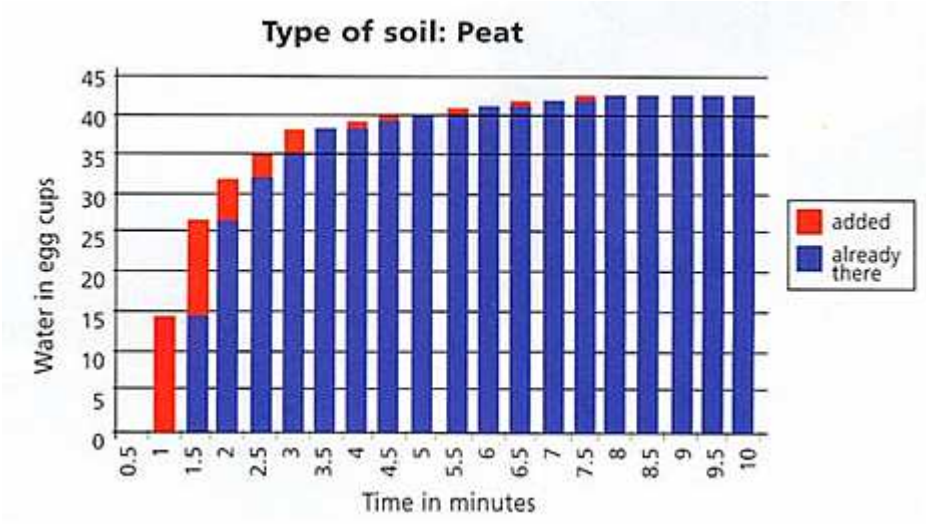
The results of their investigations were entered onto spreadsheets and the children used these to create graphs and pie charts.

The children entered their data onto three Excel spreadsheets:

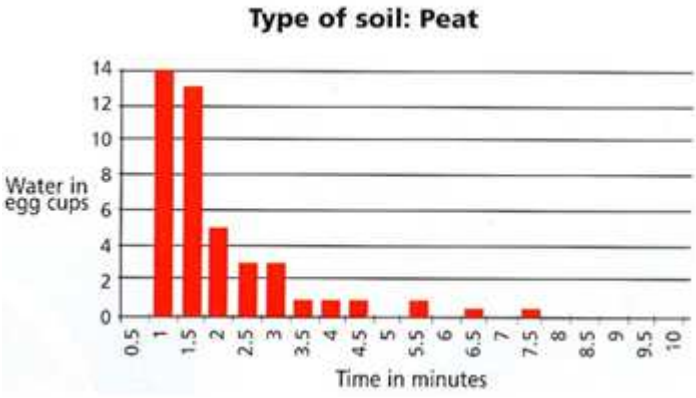
1. 'water drained after each 30 seconds'
2. 'water drained in each 30 seconds'
3. 'total amount of water drained and retained'

It was exciting for the children to enter their data into the computer as it came through but they soon found, to their cost, that their were dangers in this. If a child made an error or got into difficulties on the keyboard, the data still kept coming and panic set in! Complete sets of data could be lost or entered incorrectly. They decided to record the data on paper first and enter it on computer later. This data was converted into two types of graphs and a pie chart, using the graphing facility:

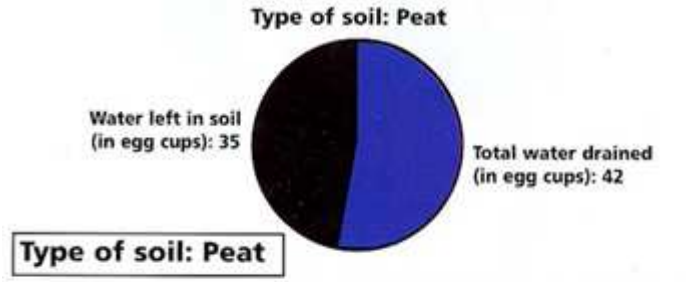
a **cumulative graph** which illustrated the amount of rainwater that had drained through the soil after each 30 seconds. The computer drew each bar as a composite of water already drained and water added in the last 30 seconds:



a **rate graph** which illustrated the amount of rainwater drained through in each 30 seconds. This graph illustrated the change in rate of drainage over a ten-minute period:



a **pie chart** which graphically illustrated the proportion of drained and retained water for each soil type:



Type of soil: Peat

Total rainfall (in egg cups):	77
Total water drained (in egg cups):	42
Water left in soil (in egg cups):	35

Interpreting the graphs and charts

Understanding flood hydrographs
The rate graph proved a particularly valuable discussion document. The shape formed by the bars beautifully illustrated a flood hydrograph, with the initial delay in drainage followed by a surge and then a tailing off. This helped the children to think about why streams and rivers do not immediately swell or flood when it starts to rain but do so some time later. It was also interesting for the children to discover that a repeat 'rainfall' on an already waterlogged bucket of soil reduced the delay time in the flood hydrograph.

Understanding the relationship between a cumulative and a rate graph
Steve found that interlocking cubes were a valuable teaching aid, helping the children understand the difference between rate, cumulative and compound graphs. By adding a different coloured set of cubes onto a stack to represent the amount of water added after each 30 seconds, the children could create a cumulative representation of the drainage. By breaking this stack apart into 30 second bites the children could convert it into a rate graph, e.g. the amount of water drained in each 30 seconds.

Comparing the drainage and water retentive properties of different soils
By placing all the pie charts from the different soils tested alongside each other, the children could make comparisons between them. They produced a water retention 'league table', which showed that the best soils at retaining water were peat and compost and the best 'drainers' were grit and bark chippings. This was the point at which the children were able to explain why peat bogs exist on Dartmoor. The pie charts clearly illustrated peat's water-retaining properties.


How soil retains water

Name	Soil	Eggcupfulls left in the soil
Cool Cats	Peat	33
Compton	Compton	20
Beano	Compost	14
Cool Four	Sand	10
D.I.Y. Girls	Coarse Grit	4
Cool Kids	Potting Grit	28
D.I.Y. Boys	Bark	8
Be Cool	Mulch mix	26

This is showing all the groups that are doing a soil experiment. It also shows how much water was left in the soil.

The 'league table' of results showing the soils that were best and worst at draining.

If this article has given you the inspiration to have a go at developing a project linking mathematics with geography or science, please let us know!

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A little bit of history
Britain since 1945

One of our readers requested that we wrote an article about Britain since 1945, so we have! In this article, we explore the period from the 1940s to the 1970s, and in the next issue we'll be covering the decases from 1980 to the present day. We hope it gives you a few ideas on how to link mathematics to 'A little bit of history'! If you have a particular history topic that you would like us to find some mathematics links for, please let us know and we'll do our best to put something together for you.

Due to the large amount of ideas and resources, this feature can only be read directly on the portal, otherwise the interactive nature of the way they are presented will be lost.

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Maths to share – CPD for your school

Mathematics: made to measure

This is the first of a two-part *Maths to share* relating to the latest Ofsted report Mathematics: made to measure. In this issue we consider the first, second, fifth, sixth and seventh Ofsted findings.

Before the staff meeting ask colleagues to read the key findings from the report, and to be prepared to discuss their current practice in the light of these.

The NCETM portal has many resources and microsites which give useful suggestions that are relevant to these key findings. This article links to a few. It may be that you would like to select those that are appropriate to your school situation to explore with your staff during your meeting.

Key findings related to EYFS and primary schools

1st finding

Children's varying pre-school experiences of mathematics mean they start school with different levels of knowledge of number and shape. For too many pupils, this gap is never overcome: their attainment at 16 years can largely be predicted by their attainment at age 11, and this can be tracked back to the knowledge and skills they have acquired by age 7. Low attainment too often becomes a self-fulfilling prophecy. Pupils known to be eligible for free school meals fare particularly badly.

2nd finding

The best schools tackled mathematical disadvantage with expert insight and ambitious determination, with policies and approaches understood and implemented consistently by all staff to the benefit of all pupils. Developing such expertise should be the goal for all schools.

- What intervention strategies do you have in place so that any lower attaining children can make enough progress to catch up with their peers?
- Are your interventions effective? If not, how could improve them?
- Does your mathematics policy specify the approaches your school takes to tackle mathematical disadvantage? Is it implemented by all staff? Does it need reviewing?

You might like to explore our guidance documents for teaching low attainers with your colleagues. You will find materials here to support the teaching of these children.

5th finding

Attainment in national Key Stage 2 mathematics tests has shown incremental rises in the proportions of pupils attaining the expected Level 4 and the higher Level 5. Improvements have also been made in children's knowledge and skills in the Early Years Foundation Stage. Teacher assessments at the end of Key Stage 1, however, indicate that attainment has plateaued and the downward trend in the proportion reaching the higher Level 3 shows no sign of being reversed.

- Have you noticed a plateauing of attainment in KS1? If so, when does this appear to be happening?
- What percentage of children achieve Level 3 in Year 2 at your school? Should this be higher?
- What good practice enables children to achieve Level 3?
- If you are a primary school, are numbers of children attaining Level 3 reduced due to concerns of achieving the required progress by the end of KS2? Is this something that you, as a school, need to address? If so, how?

You might like to consider developing the use of rich mathematical tasks in KS1. These help develop the children's thinking skills and their ability to communicate their thinking and in so doing help to raise attainment.

There are numerous resources on the NCETM portal to help you explore ways in which to develop rich mathematical tasks for your learners to engage in. Our guidance package How can I devise rich mathematical tasks for the primary classroom? shows a few and makes them quick and easy to find. Why not pick something from these to explore further with your colleagues?

Alternatively you might prefer to explore some of the ideas in Maths to share in Issue 11 of the Primary Magazine. In this article there is guidance for planning problem solving tasks which engage learners in rich mathematical thinking.

6th finding

Schools have implemented a wide variety of strategies to improve performance in mathematics. The most common strategy has been better monitoring of pupils' attainment and progress coupled with greater use of intervention programmes. In most primary schools, intervention has become more focused and timely in helping pupils overcome difficulties and close gaps.

7th finding

Despite these strategies, the percentage of pupils not reaching the expected level or grade for their age increases as pupils progress through their mathematical education, and is more marked for some groups than others. This suggests, strongly, that attaining a key threshold does not represent adequate mastery of skills and sufficient depth of conceptual understanding to prepare pupils for the next stage of mathematics education.

- Are your children well practised in taking tests, particularly KS2 SATs, but do not have adequate mastery of skills and the depth of their conceptual understanding?

You might like to consider booking a couple of staff meeting slots to work through the online Primary CPD module.

We hope that this first part has given you and your colleagues some things to think about and highlighted some possible professional development.

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