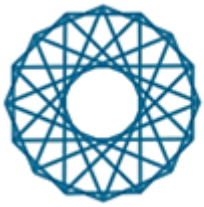
Primary Magazine
Issue 21



National Centre
for Excellence in the
Teaching of Mathematics

Welcome to the 21st issue of the Primary Magazine. Our famous historian is Mary Boole, our artist is Barbara Hepworth and our CPD opportunity aims to develop subject knowledge in the area of mass.

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From the editor

In our last issue of the primary magazine we aimed to inspire you to consider bidding for a regional project. We talked about the example on the portal from Rachel Brittain, mathematics subject leader and assistant headteacher of Red Oaks Primary School who researched the best ways to help pupils learn their times tables and involve all staff in trialling a range of methods. In this issue, we would like to inspire you further by giving you information about the South East region's Primary Maths Week Project which was organised primarily to raise the profile of mathematics and engage schools, parents, carers and the wider community in mathematical thinking – 'bring the world into the classroom and the classroom to the world'.

If you are considering organising a maths week, the NCETM regional coordinator's report and those of three of the schools that took part: St Michael's Primary School, St Benedict's Roman Catholic Primary School, Overton CE Primary School and Thurnham School may prove to be very helpful.
Don't forget, if you're inspired and wish to become involved in a project, contact your regional coordinator who will be able to advise you on the best wasy to submit a bid.

Just in case you are not aware, the new national primary curriculum website is now live. Alongside the statutory curriculum, you can view new case studies, download tools and guidance and use an interactive curriculum design tool. It has been designed so that all primary schools can evaluate their curriculum and think again about teaching and learning in the context of school improvement.

It includes: curriculum aims, essentials for learning and life, the six areas of learning and RE. The essentials for learning and life describe the skills, attitudes and dispositions that children need to become well-rounded individuals and lifelong learners. They include literacy, numeracy and ICT capability, learning and thinking skills, and personal, social and emotional skills.

There are three broad aims which should enable all young people to become:

- **successful learners** who enjoy learning, make progress and achieve
- **confident individuals** who are able to live safe, healthy and fulfilling lives
- **responsible citizens** who make a positive contribution to society.

The great news is that it provides the opportunity to be creative with maths, so teachers can now, as well as teaching mathematics discretely, make those all important links to mathematics in real life.

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Up2d8 maths

In this issue of Up2d8, we look at recent news of the problems terrapins are causing in our countryside. People who buy them as pets, notably at the time when the Teenage Mutant Hero Turtles were a craze in the 1980s and 90s, either get bored with them or they grow too big and so owners release them into the wild. Conservationists are concerned because they are growing in number and causing havoc among wildlife by eating ducks, ducks eggs, fish etc. and also by carrying salmonella.

The spreads provide a great opportunity to explore such mathematical concepts as counting, place value, money, measurement and data handling. The resource provides ideas that you can adapt to fit your classroom and your learners as appropriate.

As always, we would be extremely grateful if you could give us some feedback on how you have used Up2d8, if it has worked well and how it can be improved. You might be interested to read Paul's comments on how he has used it in his school: thanks Paul!

Download this Up2d8 maths resource - in PowerPoint format.

Download this Up2d8 maths resource - in PDF format.

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The Art of Mathematics
Barbara Hepworth (1903 - 1975)

Barbara Hepworth (1903-75) was one of Britain's most important 20th Century artists and probably the most famous female sculptor. She achieved worldwide success at a time when it was very unusual for a woman to be a sculptor. She is perhaps most famous for her abstract sculptures of pierced forms. Unlike many artists, she had a gift for mathematics.

In the 1960s, Hepworth's repertory of forms extended, from the strict geometry of her earlier work, to the more composite structure and monumental scale of her later work.

Her work can be found all over the world, for example:

- The Family of Man (Nine Figures on a Hill), 1970, Yorkshire Sculpture Park;
- Winged Figure, 1963, John Lewis, Oxford Street, London;
- Single Form, 1962-3, United Nations Plaza, New York.

Born in 1903, Barbara was the eldest of four children and the daughter of a civil engineer whose work inspired her interest in technical drawings.

At the age of 16 she won a scholarship to the Leeds School of Art, where Henry Moore was studying. Instead of doing the compulsory two years at the school she fitted the course into a single year, and went to the Royal College of Art in 1921 on a senior scholarship. She spent three years there, and in 1924 was a finalist for the Prix de Rome, which provided an opportunity to live in Italy for a year, returning to London in November 1926.

In the 1930s, Barbara married for a second time and moved to Hampstead where she and her artist husband, Ben Nicholson, were at the centre of a small group of avant-garde artists living and working in London. They also travelled widely in Europe and made the acquaintance of leading artists in France, most notably Picasso, Brancusi, Braque and Mondrian. Barbara's financial position remained precarious throughout the 1930s and in 1938 she and her family decided to leave London for St Ives.

Barbara Hepworth won increasing recognition in the decade that followed the Second World War. Like Henry Moore, her sculpture increased in scale as greater and greater opportunities were offered to her. She began to turn away from carving and to make some works, especially the larger ones, in bronze.

Hepworth's final years were beset by increasing ill health. She died in 1975 as the result of a fire in her studio.

More details of Barbara Hepworth's life can be found at www.barbarahepworth.org.uk.

A Department for Children, Schools and Families initiative to enhance professional development across mathematics teaching

Many of her sculptures involved both solid shape and open space. She carved into and through her sculptures to explore both the inside and the outside. She looked at abstract ideas about colour, line, shape, form, balance and depth in her sculptures and liked to combine geometric shape with more organic forms. She used different materials and textures in order to draw attention to relationships between forms, surfaces and subject.

A full catalogue of Barbara Hepworth's work can be found on the website set up by the Hepworth Estate. Although all the images included on the site are protected by copyright, permission is given for educational use.

Here are some examples of work that exhibit mathematical influence, but there are many more you may wish to examine:

- Pelagos (1946), formed from elm wood with colour and strings
- Sculpture with Colour (1940)
- Painted wood and strings (1943)
- Wave (1943-1944)
- Stringed Figure, Curlew (1956)
- Winged Figure (1961-1962)
- Sphere with Inside and Outside Colour (1967).

Looking at Hepworth's sculpture

Some questions to ask of any work:

- what is the first thing you think or feel when you look at the work?
- what is it made from? (eg. wood, stone, metal, plaster)
- how was it made?
- can you tell by looking what materials, tools and techniques were used?
- what shapes can you see?
- does it have an inside and outside?
- if so, what shape is the outside edge?
- what is the shape in the middle?
- can you see any lines of symmetry – reflection or rotation?

EYFS/ Key Stage 1

Creating sculptures using shapes

Ask children to collect a range of 3D shapes and arrange them as a collection. Then ask the children to give their collection a name, eg:

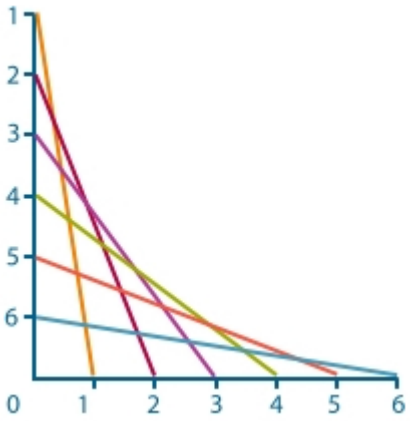
A collection of blue 2D shapes

A collection of triangles

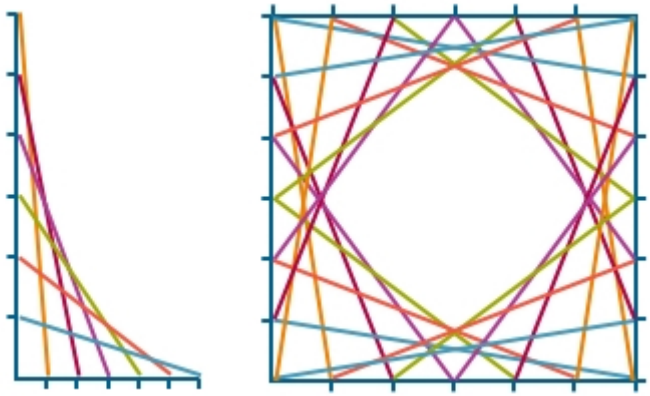
Using the shapes encourage the children to create their own sculpture as Barbara Hepworth did. You could then ask pupils to look at natural things and to start thinking about shapes. They could then create a collection of natural shapes and to give their collection a name. They could think about where their sculptures should be set – for example, in a garden, on the hillside, on a beach in a gallery.

Key Stage 2
Barbara Hepworth used string in a very clever way in her sculptures. She appears to make curved lines with pieces of straight string.

Making curves with straight lines:
Ask the children to draw axes and scale as below up to 10 on graph or squared paper. Next ask them to join the points i.e. 1, 1 with a line then 2, 2 etc. The diagram below is illustrated using different colours to show the procedure but the children should use the same the colour to gain the maximum effect. Carry on until all the points are joined.



The children can then experiment with overlapping designs, and designs using all four quadrants. The may also want to consider uneven axes. Here is a couple of examples:



These activities can look very effective on paper with a ruler and coloured pencils. However, why not work as Barbara Hepworth did - with string!

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Focus on… The structures of Isambard Kingdom Brunel

Isambard Kingdom Brunel was born in Portsmouth on 9 April 1806. His father was the distinguished French engineer, Sir Marc Brunel. Isambard received a high quality education and practical training. When he was 16 he began working for his father. It was not long before he was in sole charge of large projects. The first was the Thames Tunnel at Rotherhithe, now part of the East London over-ground railway system. At 26, he was appointed Engineer to the new Great Western Railway. He designed the railway line from London Paddington to Bristol and eventually engineered over 1 200 miles of railway.

Brunel is probably best known for designing the Clifton Suspension Bridge. At 210 metres long, it had the longest span of any bridge when it was first constructed. It was not completed until 1864, five years after Brunel's death. Almost all his bridges are still standing and in use. In 1858 he designed and built his first ship, the Great Eastern. Although he was only responsible for three ships, each represented a major advance in naval design.

Isambard Kingdom Brunel died of a stroke on 15 September 1859, aged 53. During his career, he achieved many engineering 'firsts':

- first tunnel under a navigable river
- first propeller-driven, ocean-going iron ship
- his steamship the Great Eastern played a significant part in laying the first, lasting transatlantic telegraphic cable in 1865
- widest brick-arch bridge.

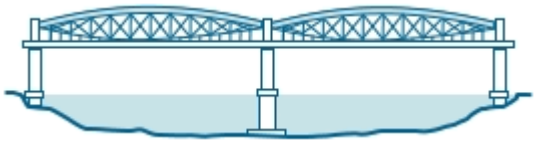
In 2002, the BBC conducted a poll to find out who were the 100 Greatest Britons. Brunel came in second place, after Winston Churchill. Charles Babbage, the mathematician who supported Brunel's construction of a broad gauge railway, carrying out a range of tests to support its safety, was 80th in the list. Brunel also featured in the 2003 BBC series Seven Wonders of the Industrial World. The first programme in the series dramatised the construction of the SS Great Eastern.

Brunel University in London dedicates several pages of its website to the life and achievements of Brunel. As well as an overview of his life, there is a very useful 3 minute video (also available on YouTube) and pictures of his greatest works.

Short activities

Use the timeline of Brunel's life on the Brunel University website or Wikipedia to answer questions such as:

- how old was Brunel when he won the Second Clifton Bridge Competition?
- how long did it take to build the Saltash Bridge?
    - how old was Brunel when he got married?
    - how many years did it take to build the Thames Tunnel?
    - how...?
- how far is it from London's Paddington station to Bristol Temple Meads station? How could you find out? Estimate, then find out
- what is the difference in width between broad gauge, standard gauge and 3ft narrow gauge tracks? Is the difference in width between broad and standard the same as between standard and narrow?
- in class, view the Telegraph's Top 10: Isambard Kingdom Brunel's great surviving structures or download and print the pictures. Remove the picture number but retain the date. Ask children to order them by date
- how long does it take to count to 100? Estimate, then time some volunteers. Challenge children to count to 100 in 100 seconds.



Longer Activities

- explore the BBC Schools Famous People pages on Isambard Kingdom Brunel. This is appropriate for Key Stage 1 children
- work in small groups to design and build a closed railway track exactly five metres long. Use existing track if you have sufficient or construct from strips of card and art straws. Invite groups to measure each other's tracks. How close are they to the target length?
- how long did it take to complete each metre of track during the building of the railway line from Paddington to Bristol? The Brunel University site has many of the facts and figures that would be needed to work this out
- build a bridge over a tray such as those used by children to store their own possessions in the classroom. Prepare a cost list for each piece of construction equipment or other materials and ask the children to calculate the cost of their bridge. Work in twos, threes or small groups if equipment is limited. It will be easier to keep track of costs as the bridge is being built in larger groups. Each member of the group could take on different roles. You could set a target figure or an upper limit

- what does 100 look like? Collect a hundred of some everyday objects – straws, cotton wool balls, tissues, sweets, etc. Set bringing in a hundred of something as homework – the children will have many ideas. How could you rank them – by weight? By size?

Information on Brunel from:

- Wikipedia
- Brunel University
- BBC Historic Figures

YouTube videos:

- Clifton Suspension Bridge
- Royal Albert Bridge

Other follow-up information:

- Bridges (for upper KS2 only)

A little bit of history
Famous Mathematicians – Mary Boole (1832 - 1916)

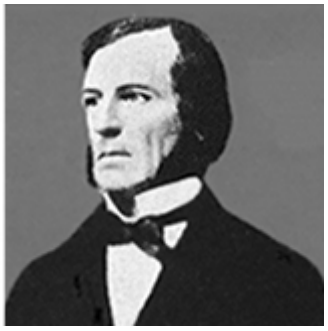
Mary Everest Boole was born in England in 1832. When she was five and her younger brother George was two, her father, Reverend Thomas Everest, moved the family to Poissy in France in order that he could be treated, through homeopathy, for a serious illness.

Growing up in Poissy gave Mary a chance to learn about a different culture and become fluent in French but she often found life difficult and lonely because her family's way of life was very different to that of the French locals. Every day she and her siblings were given school lessons by their mother, which were apparently very boring! After two hours of Mrs Everest, their tutor Monsieur Deplace took over. He was the person who first introduced Mary to mathematics. She became very fond of him, his style of teaching made it easy for Mary to do well in her studies and this was something she never forgot.

His style was probably based on Rousseau's teachings from the 18th century, which led children to new concepts through writing down the answers to a series of questions. Once they had completed these the children would analyse both the questions and their answers. In this way, they came to a better understanding than they would have if they had simply been told the information, as in the more traditional methods.

The family moved back to England when Mary was eleven. Shortly afterwards she was taken out of school to become her father's assistant. She was given various tasks including teaching a Sunday School class and helping her father with his sermons.

She didn't mind this but also didn't want to end her studies so she used the books in her father's library to teach herself calculus. She loved mathematics and had lots of unanswered questions about certain concepts which she found frustrating. It was when Mary, at eighteen, visited her aunt and uncle in Cork,



Western Ireland, that her questions were answered. Her uncle introduced her to a famous mathematician who she spent a lot of time with, and it was he who helped her mathematical expertise to grow. His name was George Boole.

After her return to England they stayed in touch through letter and two years later he came to England to teach her more about mathematics. He was 17 years older than her but despite the age difference they married when Mary was 23. They were very close companions and had a successful marriage. During the next nine years, Mary and George had five daughters named Mary, Margaret, Alicia, Lucy, and Ethel. Sadly, George caught pneumonia and died when their youngest child was just six months old.

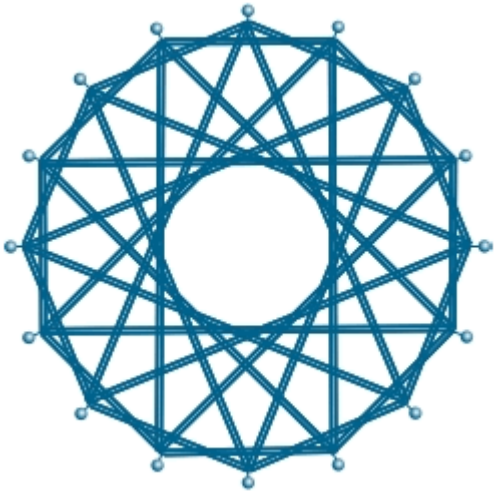
After his death, Mary began teaching, women initially and then children. She followed her tutor Monsieur Deplace's method with her own additions. She believed that children should be given mathematical objects to play with and develop, at their own pace, ideas of order and pattern. She invented curve stitching, or what we call today, string geometry, to help children learn about the geometry of angles and spaces.

She was an outstanding teacher. One of Mary's pupils wrote to her saying: “I thought we were being amused not taught. But after I left I found you had given us a power. We can think for ourselves, and find out what we want to know.”

Mary believed that it was possible to express all basic notions of the universe with numbers and symbols. At the age of 50, she began writing a series of books and articles about this, publishing them regularly until the time of her death in 1916 aged 84.

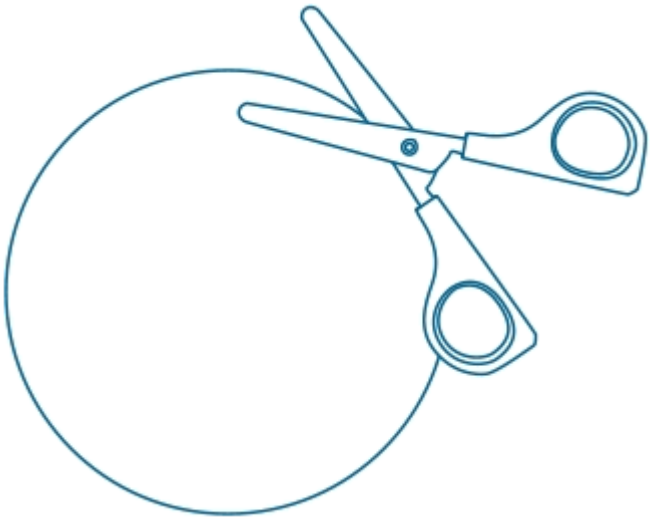
Mary Everest Boole was an amazing woman who, widowed for 50 years, raised her five daughters on her own and also managed to make countless contributions towards the mathematical education of many girls and boys which can be seen in the modern classroom today.

You could have a go at some string geometry with your class. This would provide an ideal opportunity to explore fractions, shapes and angles. Why not try this one?

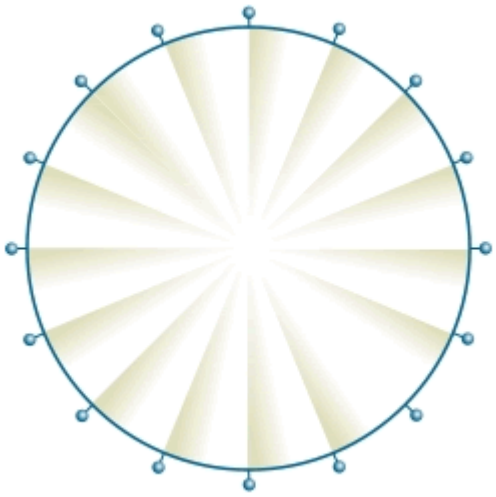


You will need paper, scissors, pins and lengths of different coloured wool or thread.

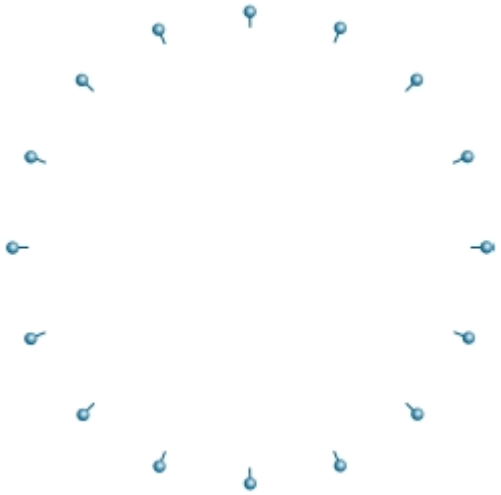
First of all, ask the children to draw round a circle and then cut it out:



They then fold it in half, half again and then twice more to make 16ths:



Next, place it on a piece of paper, stick pins on the paper at the ends of each of the folds and then take the paper circle away:



Tie the end of one piece of coloured wool or thread to one of the pins. Next, create a repeating pattern wrapping the wool once around the other pins. You could wrap around every two pins, three, six or nine pins. Repeat the pattern you chose beginning at each of the other pins until you get a pattern like the one in the picture.

More details are available on the Unplug Your Kids website.

Barbara Hepworth made various scultures and artwork using a similar idea. See this month's article The Art of Mathematics for some more ideas for string patterns.

Mary's husband George is famous for his Boolean number system, which is a very complex form of algebra. Conversions of his work are often used in creating electrical circuits. If you are interested in finding out more you could watch this video.

Information sourced from:

- University of Zimbabwe
- Agnes Scott College.

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Maths to share – CPD for your school

Measure - mass




It is common with most areas of measure (length, capacity, mass) to find less progression in skills across key stages than there might be in other more frequently taught areas of the curriculum, such as calculation. Teachers often find it difficult to know where to 'pitch' their teaching, and so revert back to early skills and build up again. There can also be a reluctance to allow pupils to 'play' with measures and so practical activities are limited.

Before the session, ask teachers (anonymously) to write down and bring one 'concern', 'anxiety', or 'area for development' relating to the teaching of mass. Collect these together and group them if appropriate. Hold an open discussion around the points raised, and allow colleagues time to provide advice and support each other. All too often, pockets of good practice exist in schools, but are confined to individual classrooms.

This might be an appropriate point to ensure that all teachers are comfortable with the difference between 'mass' and 'weight'. 'Mass' is the amount of matter or substance and can be measured in grams, where 'weight' is the amount of pull something exerts and is properly measured in Newtons. In space, a spaceship is weightless because there is no gravity, but its mass is the same as when it was on earth. We should continue to use 'weight' as this is the phrase children will be most familiar with, although they need to understand to what the term 'mass' refers.

It would be helpful to familiarise yourself and the staff with the units of mass and how they relate to other standard measures. You could take some information from this Wikipedia entry.

The article A Little Bit of History in issue 11 of the Primary Magazine focused on the history of weight, and is an interesting read. Encourage all teachers to do so – there are some interesting points to share with the children too!

Display the following question and allow colleagues time to consider how they might work towards an answer:

Would you rather have a column of £1 coins as tall as you, or a collection of 5p pieces as heavy as you?

A Department for Children, Schools and Families initiative to enhance professional development across mathematics teaching

Share the outcomes of their discussions. What key points do they include in their arguments? Ask them to consider the mathematical skills, equipment or key facts they would need to use to reach a solution. Did they use any estimation skills? For those wanting to calculate a solution, it may be helpful to know that the thickness of a £1 coin is 3.15mm, and a 5p coin weighs just 3.25g!

'Open' questions such as these, which require a great deal of exploration and application of skills, can be extremely useful in the classroom. Other 'open' questions might include:

- if you lined up counters for 1km, how much would they weigh?
- my dad says that together, he and I weigh nearly half as much as an elephant. Can he be correct?
- how much sugar does the staff get through in a week? (With this they will need to talk about the fact that they are translating a measure of volume (number of spoonfuls) into a measure of weight (grams and kilograms)).

Encourage the children to invent their own questions for the class to investigate.

Next, ask colleagues to consider the progression in 'weight' skills needed to be taught throughout EY/FS, KS1 and KS2. Provide them each with a copy of the skills sheet. Allow time for them to work in pairs to cut them out and rearrange the statements into the order they would first be taught. They might be able to add year group labels to some. Spend some time discussing the results, and sharing teachers' ideas.

The importance of providing pupils with opportunities to 'play' or explore, at all stages, when weighing should not be underestimated. Teachers TV hosts a wonderful Number Crew clip Roller Coaster II, based on a problem of allowing different animals to ride a roller coaster, depending on their weight. It clearly demonstrates the early concept of measuring mass using uniform non-standard units, in a fun, child-friendly way. 'Fishy Scales' is a wonderful book by Calvin Irons, available in several formats, including 'Big Book'. This is another fantastic starting point for discussing the early notion of uniform non-standard units, and estimating measures. It has bright illustrations and follows the story of the sea creatures trying to weigh each other under the ocean floor.

Once pupils are secure with the basic language of mass ('heavier' or 'lighter'), and then the notion of uniform non-standard units, they can be introduced to accepted standard units, ie. grams and kilograms. Focus colleagues' attention on this statement: Being able to convert units of weight from metric (kg, g) to imperial (pounds, ounces) and vice-versa, from the skills sheet used earlier. How necessary do they feel this skill is for pupils at primary school level? Why? Discuss the fact that ingredient quantities for many recipes are now given in both metric and imperial, and that most adults still only know their weight in stones and pounds.

Now ask them to consider the following question:

Will all of the children in your class together weigh more than one tonne?

As teachers, we often ask children questions of a similar style in the classroom, e.g. 'Do you think this shoe weighs more than one kilogram?' when, in fact, they have very little concept of what a kilogram actually is, or feels like. Do colleagues have similar feelings regarding a tonne? If necessary, inform them that 1 tonne is equivalent to 1 000kg. If they can imagine filling a box measuring 1m x 1m x 1m with water (at 4° Celsius), then it would weigh a tonne!

With any of the areas of measurement, teachers should plan to teach the main concepts through practical activities which include:

- use of vocabulary
- knowing the relationship between units
- suggesting suitable units
- recording estimates
- reading from scales
- using standard metric units
- suggesting suitable tools.

There should be planned opportunities for problem solving, many good examples of which can be found on the internet. The NRICH site hosts a good selection of problems involving mass, at all levels. Children can submit their own answers too, and read those of other children around the country. Simple comparison problems can be used from a very young age, and can provide a useful insight into a pupils' understanding. Examples could include:

Five bricks balance a spoon. Three bricks balance a ruler. How many bricks will balance the ruler and the spoon together?	These cubes balance these marbles...these marbles also balance the book. What can you tell me about the cubes and the marbles?

Above all, the most important aspect of teaching and learning measures is to allow time to experiment with 'real life' objects and situations. Worksheets asking young children to match objects to their weights, including items such as eggs and articulated lorries weighing approximately 50g and 44 tonnes respectively, are not 'real life' for most children!