Secondary Magazine Issue 46

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 46 of the Secondary Magazine. So we begin the countdown to Christmas – lights have been turned on and the shops are full of glittery merchandise. Before you get totally engulfed in Christmas preparations – we hope this Issue will divert your attention towards mathematics.

Contents

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From the editor - What does it mean to be functional in mathematics?

I suppose, if you are a teacher of mathematics, then your attention will be drawn to the mathematics of the things that happen around you. Here are three things that my attention has been drawn to recently – as you read the stories you may want to consider their relevance to functional mathematics.

Story One
My husband has now fully recovered from his heart attack. A year ago he was in A & E. So scary. It's strange how you remember some bits so vividly. The excellent doctors asked the fantastic nurse to administer 0.5mg of a clot-busting drug – she got out her phone. What?! 3mg of the drug was dissolved in 10ml of a saline solution and she was working out how much solution to give…

Story Two
We have recently had our bathroom tiled. It looks fantastic. The wall tiles are 60cm x 30cm and the floor tiles are 30cm x 30cm. It would be impossible to line up the wall and the floor tiles exactly so I thought my eye might be drawn to the inconsistency of the arrangement. I asked the tiler if he could lay the floor tiles so that the edges of the tiles were at 45° to the wall. He turned a shade of green and said we would have to negotiate a different price… Why is that so hard? He has still cut every tile…

Story Three
There was a great recipe in the newspaper a couple of weeks ago to make cheese. Really simple instructions – mix equal quantities of goat's milk yoghurt (4% fat) and ordinary yoghurt (2% fat). Add a bit of salt. Suspend in a muslin bag to drain off the whey. Leave for 36 hours. Hey presto – cheese. My husband is very conscious of fat in the diet (see Story One) so was overjoyed – 3% fat – cheese I can eat. Or is it?

So do these stories have a bearing on what it means to be functional in mathematics? How would they score in the functional skill assessment areas of complexity, familiarity, independence and technical demand?

I think there is a degree of **complexity** in each of the stories. That's what makes them interesting for me. While proportionality is a big idea in mathematics, using a 'nasty' multiplier or a two step problem using a unitary method makes the situation complex. The tiling problem goes beyond some peoples' intuitive feel for shape. And what is it I am finding a percentage of to make decisions about cheese?

These situations have a high degree of **familiarity** to me – they were my stories. They may not be familiar to learners but could they engage with these situations? Could learners generate their own 'stories' to work on?

It is hard to comment on **independence** in this context, but giving pupils exposure to mathematical problems within the supportive atmosphere of the classroom would encourage them to be able to show more independence in tackling problems in real life.

None of these stories include very difficult mathematics, do they? The **technical demand** is low. If the three concepts were given as straightforward questions they would not be very difficult – would they? Proportional reasoning, spatial awareness/tessellation and percentages: ideas commonly encountered in mathematics.

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So how are we preparing pupils to be functional in mathematics? Have we got our own mental picture of what functionality in mathematics would look like? I will certainly keep referring back to these stories as I develop my ideas of functionality and give learners the opportunity to engage with complex yet every day mathematical situations. Why not tell us what you are doing?

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Up2d8 maths

The fortnightly Up2d8 Maths resources explore a range of mathematical themes in a topical context. The resource is not intended to be a set of instructions but rather a framework which you can personalise to fit your classroom and your learners.

On 7 November 2009, British heavyweight boxer David 'Hayemaker' Haye fought Nikolai 'Beast from the East' Valuev. Promoted as David vs Goliath since, despite being an impressive 6ft 2in tall, Haye was dwarfed by his opponent! Valuev's measurements are enough to strike fear into most people – he is 7ft 2in tall, weighing 23st with a 52in chest!

This resource uses the size difference between these two sportsmen to explore proportional reasoning. The activity looks at similar shapes and invites students to use proportional reasoning to calculate a multiplier in order to enlarge themselves. Students look at the difference between the two fighters and are then asked to put themselves in David Haye's shoes. If they were David Haye, what would be the measurements of Nikolai Valuev? You might decide that the students should simply measure themselves (maybe at home in preparation for the lesson) and use their own individual measurements or you might use the opportunity to create an 'average student' from the class and enlarge this fictional student.

This resource is not year-group specific and so will need to be read through and possibly adapted before use. The way in which you choose to use the resource will enable your learners to access some of the Key Processes from the Key Stage 3 Programme of Study.

Download the Up2d8 Maths resource - in PowerPoint format.

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The Interview

Name: Andrew Young

About you: I have worked for the National Centre since shortly after its launch in 2006. I have also worked in the investment arm of a high street bank, as well as digitising maps and plans for a major utility company. When I'm not at work, my major pastime is music.

The most recent use of mathematics in your job was... Putting together work schedules for the Centre's online magazines – trying to make sure that we have enough time and people for the work involved.

Some mathematics that amazed you is... The Golden Ratio and Fibonacci Numbers – and how they relate to music.

Why mathematics? Because it's everywhere – we all do it even if we don't realise it.

Your favourite/most significant mathematics-related anecdote is…
The story that appears in Robin Wilson's book *Lewis Carroll in Numberland*. Queen Victoria liked *Alice in Wonderland* so much, that she asked for a copy of Lewis Carroll's next book to be sent to her as soon as it was published. She duly received a copy of *An Elementary Treatise on Determinants*.

A maths joke that makes you laugh is…
Very loosely mathematical…two French cats, *un-deux-trois* and *six-sept-huit*, decide to swim the Channel. Which one reached the other side first? *Six-sept-huit*, of course, because the *un-deux-trois* cat sank.

Something else that makes you laugh is…
Armstrong and Miller, Victoria Wood, Alan Bennett, E F Benson's Mapp and Lucia books, and I'm Sorry I Haven't a Clue.

Your favourite television programme is… I enjoy watching David Suchet as Hercule Poirot – his portrayal is very close to the books. I've also started watching FlashForward – I'm intrigued to find out why some of the characters can remember their future.

Your favourite ice-cream flavour is… Dime bar (from Nigella Lawson's *Forever Summer*).

**Who inspired you?** Perhaps not a 'who' but a 'what'. Coming to the NCETM as a 'non-mathematician', I find that my appreciation of mathematics is always growing, so I suppose I would say some of the materials I work with that I wouldn't otherwise explore.

If you weren't doing this job you would… Be even more involved with music – as long as I didn't have to do it to pay the bills: that could take some of the pleasure out of it!

Focus on...Conic Sections

- The four conic sections are the circle, ellipse, parabola and hyperbola:
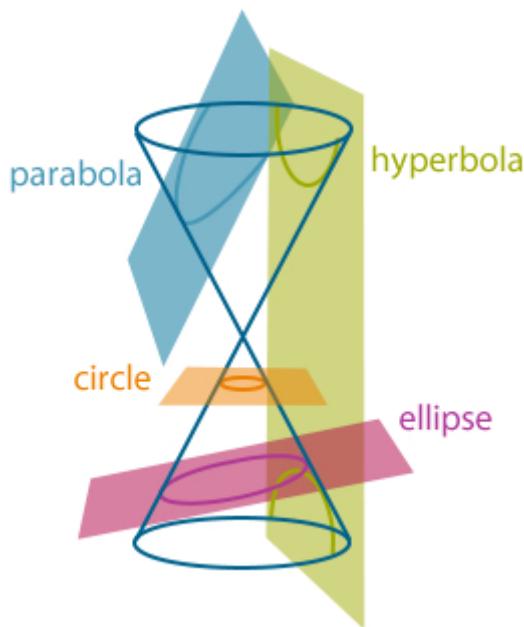
- Both Euclid and Archimedes are known to have studied conic sections, but the first work to explore them is thought to have been carried out by another ancient Greek mathematician, Menaechmus (380–320 BC).

- Conic sections can be defined by the locus of a point moving according to certain rules. For a **circle** the point moves so that it is a constant distance from one other fixed point, but if it moves so that the sum of the distances from two fixed points is a constant then an **ellipse** is formed. A **hyperbola** is the locus of a point moving so that the difference of the distance from two fixed points is a constant.
A **parabola** is the locus of the point which moves so that its distance from a fixed point is the same as its perpendicular distance from a line.

- The Conic sections can also be defined by the equation of the line on a Cartesian grid.

A circle is defined by the equation:

$$x^2 + y^2 = r^2$$

An ellipse is defined by:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

A hyperbola is defined by:

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

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And a parabola is defined by:

$$x^2 = 4ay$$

- The Cartesian definitions arise from the graph of the general quadratic equation
  $Ax^2 + Bxy + Cy^2 + Dx = Ey + F = 0$ which generates each of the conic sections depending on whether
  $B^2 - 4AC$ is positive, negative or equal to zero (giving a hyperbola, an ellipse or a parabola
  respectively. If $A = C$ and $B = 0$ then the equation defines a circle).
  You can explore this equation further using this Geogebra applet.

- In the 17th century, the German mathematician and astrologer Johannes Kepler realised that the
  orbits in which planets move around the sun are elliptical, rejecting the idea of circular orbits.

- The light cone created by a table lamp with a circular shade generates the conic sections on its
  surroundings. The circle can be seen on the ceiling above the lamp but, if the lamp is tilted, this
  becomes an ellipse.
  The hyperbola can be seen on the walls directly above and below the lamp.
  There are images and other demonstrations on The Garden of Archimedes website.

- Are McDonald's golden arches made from two parabolas? Find out from the Texas A&M University
  Mathematics Department website.

An idea for the classroom – cre8ate Maths

I was given a flier advertising this website at a recent conference. I was initially put off looking at it as you need to register, but it takes seconds and is definitely worthwhile.

cre8ate Maths is a CPD project for teachers in Yorkshire and Humberside who are developing and testing new curriculum materials at Key Stage 3. The website states that:

> 'The structure of the resources matches the twelve priority work/industry sectors in Yorkshire and Humberside. Resources for each sector will include activities that relate to the industrial or work related aspects of the context. The key characteristic of all the resources is that they link *real and significant mathematical thinking with authentic real world applications*.'

The twelve priority work/industry sectors are:

1. Growing food
2. Working with chemicals
3. Childcare/early years
4. Building for the future
5. Digital design
6. Making things work
7. Food and drink
8. Health and social care
9. Working at play
10. Getting there
11. Retail services
12. Working with others

I had a look at the 'Building for the future' section and found a resource called 'Rigid Structures'. The introduction states:

> 'This set of activities provides the teacher with a great way of looking at new or local landmark buildings whilst introducing youngsters to key aspects of shapes and construction of accurate drawings in a motivating problem solving context.'

Pupils are asked to find and record, via a sketch or a digital camera, rigid structures in their environment. Pupils then create a structure using geostrips and are asked to consider if it is rigid. What could pupils add or take away from their structure to ensure its rigidity? Finally pupils make a framework of squares then

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predict and test which braces are need to make the structure rigid.
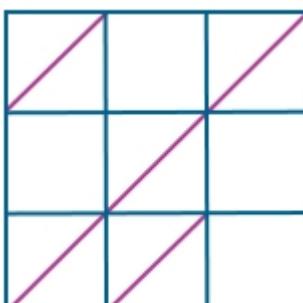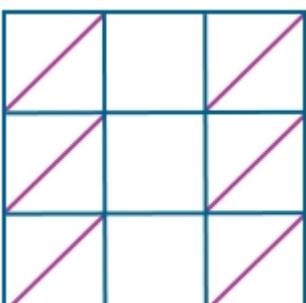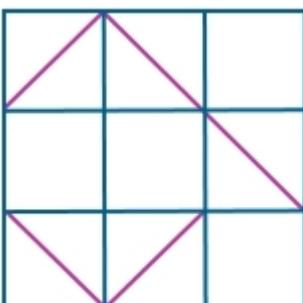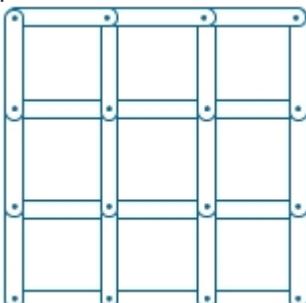
Another interesting resource was in the section Childcare/early years. The resource is called 'Keeping Baby Warm'. Pupils are invited to consider why it is important to wrap up a baby to keep it warm. Pupils make a model of a baby and an adult. They then calculate the volume and surface area of each model – possibly using a spreadsheet, but this is not provided – and compare the answers. Each resource is attractively presented with contemporary photos and is likely to appeal to pupils. The resources are not closely structured, rather like the Up2d8 resources in our Secondary Magazine, but allow teachers to construct a project using the stimulus of the packages.

Do have a look at this website and tell us what you think.

www.ncetm.org.uk

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

5 things to do this fortnight

- [Maths Inspiration](#) is one of the largest maths enrichment programmes for teenagers in the UK – reaching over 10 000 students in 2008/09! It's a chance for Year 11s and sixth-formers to experience the UK's most inspiring mathematics speakers live, in big venues, presenting mathematics in the context of exciting, real-world situations.
  On 19th November at Chatham Central Theatre, Simon Singh, Hugh Hunt and Rob Eastaway will be the star attractions!
  The content is ideal for Year 12s and for more motivated Year 11s.
  More details of this and other Maths Inspiration events can be found on their [website](#).

- On Saturday 14th November Professor Malcolm Swan will lead the Meridian branch of the ATM/MA meeting looking at developing mathematical concepts and processes through discussion. Malcolm will lead interactive sessions for all participants and also for primary and secondary colleagues separately, using group activities that encourage pupils to:
  - classify, define and compare
  - formulate and simplify, analyse and solve, interpret and evaluate, communicate and reflect.
  More details can be found on the [event flyer](#).

- Maths meets comedy on Friday 13 November at St James' High School in Exeter, where stand-up mathematician and finalist of [NESTA Famelab 2009](#), [Matt Parker](#) is performing from 7pm. [Contact the school](#) for details and tickets.

- How are you preparing for the 2010 changes to Key Stage 4? Many of the exam boards are touring events giving details of the changes. This round of the Edexcel events finishes on 4 November with an online session running in the afternoon. On the same day OCR start their [round of meetings](#) in Preston.

- Friday 20th November is BBC's [Children in Need](#). Don't worry, you've still got time to work out how you're going to make a fool out of yourself in front of your students in the name of charity!

Diary of a subject leader

Real issues in the life of a fictional Subject Leader

I'm in what would appear to be the very fortunate position of teaching both a Year 11 top set and a Year 10 top set. I only joined my school last year and am still working with my students to establish their positive work patterns and enquiry skills. My school is small, so there is a large range of ability within the groups. Students' target grades range from C to A* in both groups. Their CAT scores range from 102-141 in my Year 10 group and 93-128 in my Year 11 group. Not too much to split the groups it seems. However, in the classroom, there could not be a bigger difference.

If I throw an Up2d8, or other open activity at my Year 10 group they are away. They attack (not always where I had hoped but that makes for more thrill). Year 11, they sit. They just about have sufficient manners for me to give a brief intro – no more than five minutes or they ignore. Then they sit. I circulate and 'gee-up' each of the six islands I have in my room. When I leave their island, students sit (and chat):
 "This is a **** activity – you haven't told us how to… you haven't taught us…", Year 11 will assert.
 "Decide for yourself what you want the answer to be… estimate a value… look it up on the internet… can you approximate a method…?" I will reply.
"You're supposed to be the teacher," they return.
"And what does that mean… and anyway are you not the learner?" I will retort.
Year 11 sit (and chat and draw cartoons on books).

If I throw 10 text book questions at Year 10, they crack on with the first couple of questions and then…
"It's boring… they are all the same…" they moan.
"Life's boring… just do the odds… and what would make the question more interesting or tricky?" I might reply.
"Well question seven is a good one because it's back to front – you have to really get it to solve the problem… or… stop whinging, I like it when we do lots of the same… it helps me practice," can sometimes happen.
Throw 10 text book questions at my Year 11's and… they sit (and chat and draw and chew). They might open a book. But only two of the six islands will have it on the correct page, unless I go around and turn to the correct page for them.

I gave both groups a mock paper in preparation for a module exam.
Year 10 were instantly silent. We peer-marked so they could see instantly what they achieved. They deliberated at length as to the detail of the mark scheme on the whiteboard, taking care to note exactly where 'extra-marks' might be gained. Year 11… you've guessed it. They sat (and chatted and drew and chewed and a few tore holes in the paper.) When I returned the marked papers (they couldn't be bothered to mark their own or anybody else's… they sat and chatted and drew and chewed and a few tore holes in the paper and a few said, "Whatever").

I don't like feeling like Year 11 make me feel. Consequently, I have worked really hard to change that… but whatever I do they just seem to… sit and… I have to make judgements about the quality of teaching and learning in my team. I am very happy to make a judgement about the quality of learning of the students in both my groups. The judgements will be poles apart. Judging the quality of teaching… What would you think?