Secondary Magazine Issue 28

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 28 of the Secondary Magazine. Did you have a good half-term break? Holidays are so important to recharge our physical and mental batteries – it seems that we can then come back to work 'ready for anything'. Will you choose to use the classroom resources in the Up2d8 and the 'Idea for the classroom', or will it be that the '5 things to do' inspires you to tackle some issues or will you appreciate some 'beautiful mathematics'? We hope there is something in this issue for everyone.

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The beauty of mathematics

There I have just spent a happy hour poring over my computer, not working but ordering my seeds for 2009. Following the 'red' theme of last summer, I have ordered red onions (Scarlet Baron), crimson-flowered broad beans, purple-podded peas, French beans (purple tepee), pink fir apple potatoes and red cabbage. New for 2009, I have added some interesting looking purple carrots (can you ever get them to grow straight?) and some red salad varieties. I know that when they arrive it will give me a huge amount of pleasure as I unpack the seeds, trying to work out where I will plant them this year and when they should be sown to get the best start in our varied weather. I have a friend who is a market gardener, he would be laughing at this themed planting and chiding me over the lack of cost effectiveness in my crop. I certainly don't do this because it is cheaper – I do it because it gives me enormous pleasure.

I suppose I could say the same thing for mathematics. Although the subject is inherently 'useful', it is not this aspect which really draws me. Being able to balance a bank account and make informed decisions about mortgages and loans could be seen as a useful by product of enjoying mathematics for its own sake.

Take this pattern:

$$1 \times 8 + 1 = 9$$
$$12 \times 8 + 2 = 98$$
$$123 \times 8 + 3 = 987$$
$$1234 \times 8 + 4 = 9876$$
$$12345 \times 8 + 5 = 98765$$
$$123456 \times 8 + 6 = 987654$$
$$1234567 \times 8 + 7 = 9876543$$
$$12345678 \times 8 + 8 = 98765432$$
$$123456789 \times 8 + 9 = 987654321$$

or this one:

$$9 \times 9 + 7 = 88$$
$$98 \times 9 + 6 = 888$$
$$987 \times 9 + 5 = 8888$$
$$9876 \times 9 + 4 = 88888$$
$$98765 \times 9 + 3 = 888888$$
$$987654 \times 9 + 2 = 8888888$$
$$9876543 \times 9 + 1 = 88888888$$
$$98765432 \times 9 + 0 = 888888888$$

or this one:

$$1 \times 1 = 1$$
$$11 \times 11 = 121$$
$$111 \times 111 = 12321$$
$$1111 \times 1111 = 1234321$$
$$11111 \times 11111 = 123454321$$
$$111111 \times 111111 = 12345654321$$
$$1111111 \times 1111111 = 1234567654321$$
$$11111111 \times 11111111 = 123456787654321$$
$$111111111 \times 111111111 = 12345678987654321$$

Why does that happen?

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

These naturally occurring patterns do provoke that sense of 'pleasure and wonder' which we hear about:

> *Mathematics equips pupils with uniquely powerful ways to describe, analyse and change the world. It can stimulate moments of pleasure and wonder for all pupils when they solve a problem for the first time, discover a more elegant solution, or notice hidden connections.*
> Programme of Study - Mathematics QCA 2008

Try this activity with your students if you want to see some 'amazement' in the classroom:

> Cut out a circle from a piece of paper. Mark a point inside the circle, fairly close to the edge. Fold and crease the circle so that the circumference just touches the point, draw the crease in pencil. Repeat the folding and drawing procedure several times.

Pupils in Key Stage 3 classrooms enjoy seeing this shape 'appear' from nowhere and it is possible to link this to the orbit of planets around the sun, as described by Kepler, or the intersection of a plane and a cone.

I have just had an amazing moment myself in researching this article: I have watched an ellipse drawn by the locus of a point attached to the radius of a circle radius r rolling around the inside of a fixed circle of radius R when R = 2r. Click here to see it for yourself!

Mathematics seems to have had a new importance accorded to it schools. Headteachers are, rightly, looking at English and mathematics with a different focus as they want to improve their overall 5A* - C with English and mathematics score. Having got the spotlight shining on us, it is important that we can speak up for our subject in a well-rounded way and portray its many facets. The notion of beauty or pleasure attached to mathematics seems anathema to some of our colleagues, so it is important that we can highlight this aspect of the subject alongside some of its more 'useful' functions.

If you need some support you could quote Poincaré and Bertrand Russell:

> *The mathematician does not study pure mathematics because it is useful; he studies it because he delights in it and he delights in it because it is beautiful.*
> J.H.Poincaré (1854-1912), cited in H.E.Huntley, The Divine Proportion, Dover, 1970.

> *It seems to me now that mathematics is capable of an artistic excellence as great as that of any music, perhaps greater; not because the pleasure it gives (although very pure) is comparable, either in intensity or in the number of people who feel it, to that of music, but because it gives in absolute perfection that combination, characteristic of great art, of godlike freedom, with the sense of inevitable destiny; because, in fact, it constructs an ideal world where everything is perfect but true.*
> Bertrand Russell (1872-1970), Autobiography, George Allen and Unwin Ltd. 1967, v1, p158.

Could you tell us about some aspects of mathematics that give you 'moments of pleasure and wonder'?

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.

In January, a set of octuplets was born in California. They were only the second set to be born. Can you imagine that – eight babies all at once? What sort of issues would that raise for you and your family? What would your daily routine be like? How would you go shopping or take a stroll? How long would bath-time take? How many bedrooms do you need in your house?

As the babies were born prematurely by caesarean section they were all very small. Using data from the previous octuplet births in 1998, pupils are asked to think about the sizes of the babies. Can they visualise how heavy they are compared to other known weights? How big are they? How fast will they grow?

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.

Click here to download the Up2d8 maths resource - in PowerPoint format.

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The Interview

Name: Colin May

About you: I am the Programming Director for North Devon Theatres and Festivals.
We have two theatres: the Queens Theatre in Barnstaple and the Landmark Theatre in Ilfracombe. I am responsible for the booking/programming of theatrical productions, ballet and opera companies, contemporary dance, individual acts (comedy, music, world, blues, folk and jazz from around the world.) This involves the negotiation of fees, arranging payment methods, publicity, accommodation – and sometimes travel requirements – technical arrangements, issuing contracts, monitoring of ticket sales and strict budgets. Finally, I have to ensure no programming clashes between the two theatres and other venues in close proximity. I started my career as a theatre technician in London's West End, progressed to production management and then into venue management and programming, which I have done for the last 30 years.

The most recent use of mathematics in your job was... I use simple mathematical calculations every day to around risk management of events booked, e.g. cost of shows against potential income using mathematical ratios. There are many unknown factors such as weather and the economy which can come into play and have to be included. I can then decide on ticket prices and calculate gross income, less government and other taxes.

Some mathematics that amazed you is... formulas. I never could get my head around the complexity of them but I know they are so useful to me.

Why mathematics? Without mathematics, I could not do my job or live.

Your favourite/most significant mathematics-related anecdote is… *What is a cynic? A man who knows the cost of everything but the value of nothing.* Oscar Wilde.

A mathematics joke that makes you laugh is… How many technicians does it take to change a light bulb? Answer: four – two to hold the ladder and one to place the bulb inside the light fitting, the other to make the tea.

Something else that makes you laugh is… *Just a Minute.*

Your favourite television programme is… *Have I Got News for You?*

Your favourite ice-cream flavour is… Blueberry Yoghurt.

Who inspired you? Louis Fleming who taught me the value of always taking into consideration other people's problems. Michael Tearle (former venue manager) who taught me to sometimes take risks on artistic merit alone.

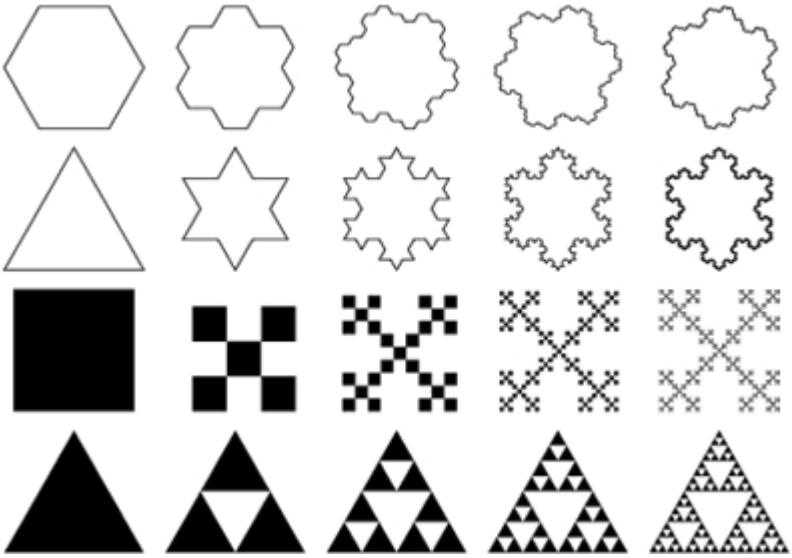
If you weren't doing this job you would… be flying commercial aircraft.

Focus on...fractals

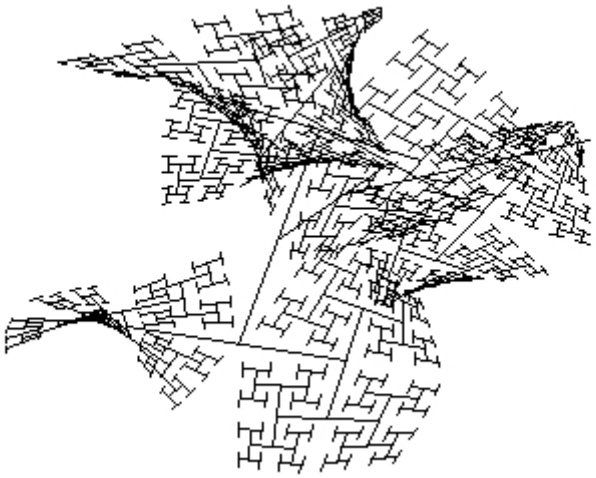
Wikipedia states that:

A fractal is generally "a rough or fragmented geometric shape that can be split into parts, each of which is (at least approximately) a reduced-size copy of the whole," a property called self-similarity. The term was coined by Benoît Mandelbrot in 1975 and was derived from the Latin fractus meaning 'broken' or 'fractured'. A mathematical fractal is based on an equation that undergoes iteration, a form of feedback based on recursion.

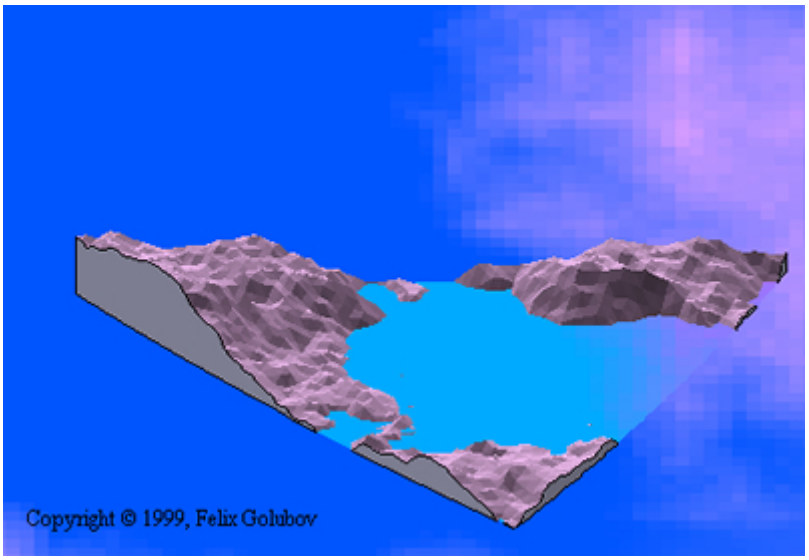
A fractal is an object or quantity that displays self-similarity in a somewhat technical sense, on all scales. The object need not exhibit exactly the same structure at all scales, but the same 'type' of structures must appear on all scales. A plot of the quantity on a log-log graph versus scale then gives a straight line, whose slope is said to be the fractal dimension. The prototypical example for a fractal is the length of a coastline measured with different length rulers. The shorter the ruler, the longer the length measured, a paradox known as the coastline paradox (Wolfram Mathworld).



Have a look at this addictive Moving Fractal Tree from José Ángel González Rodríguez' website:



Check out the fractal landscapes generator. Shapes of mountains and clouds really are fractals and the algorithm for their generation literally follows the fractals' definition:



A fractal is a geometric shape that can be subdivided in parts, each of which is (at least approximately) a reduced-size copy of the whole.

Such a fractal-generating algorithm is a very simple one and it is almost the same for mountains as for clouds. Both of them are generated by the recursive procedure that picks random values for the corners of some simple shape and then recursively fractures it to obtain the next shape. The fractured shape for mountain generation is a triangle and each value stands for altitude, whereas the fractured shape for clouds is a rectangle and each node's value should be transformed to colour. Random values are averaged with nearest nodes' values so both rock surface and clouds look sufficiently smooth.

To view some other fractals, click here

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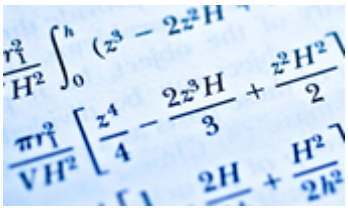

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An idea for the classroom – solving equations

I think I have already mentioned on these pages that I have spent some time over the last term, using the GCSE exam board's on-line analysis tool to find some strengths and weaknesses from last summer's examinations. I was particularly looking at those pupils who achieved a Level 6 in their Key Stage 3 SATs and did not go on to achieve a C+ grade at GCSE.

It was absolutely no surprise to find that many areas within the overall heading of 'algebra' caused pupils a variety of problems. At times like this I am inclined to beat myself up for not teaching these ideas well enough, until I am reminded that until the pupils are ready to make sense of what they see, I cannot force them to understand (even though lots of them would love to understand – only if just to please me!).

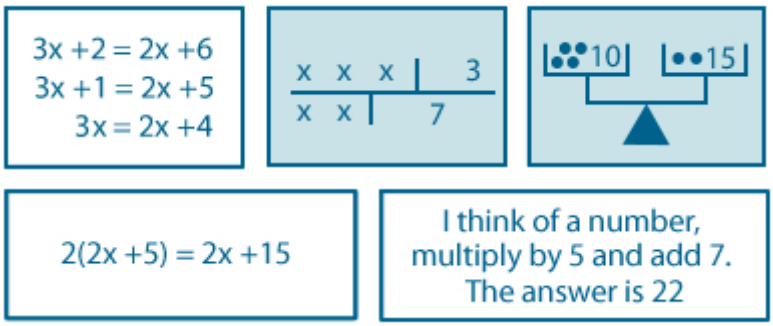
One of my guiding principles is the following from the Non-Statutory Guidance to the National Curriculum, published in 1989:

> *The teachers' job is to organise and provide the sorts of experiences which enable pupils to construct and develop their own understanding of mathematics, rather than simply communicate the ways in which they themselves understand the subject*.

So, with this in mind, I decided to construct an experience which may allow another group of pupils the opportunity to develop their own understanding of equations.

The resource is an 'equations card sort' which takes the form of a multiple representations activity. Pupils are given a set of cards to sort into the appropriate groups.

Here are some of the cards, which show a mixture of diagrams, traditional solutions, words and equations:



When you look at the resource, you will see there are several blank cards. I've found that getting pupils to generate 'missing' cards is a good way of giving them confidence and hopefully consolidating their understanding. Equally, making up a completely new 'set' of cards also helps.

Why not try this activity and tell us how you got on?

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5 things to do this fortnight

It's Red Nose Day on Friday 13th March. In all the Red Nose Days so far, 50 million red noses have been sold - How many could you fit in your classroom?! Would all 50 million fit in the sports hall?! Or in the swimming pool? The main hall?! How much space would 50 million Red Noses take up? Why not investigate?!

What are you doing for **World Maths Day 4 March 2009**?
For the 2008 World Maths Day, 182,455,169 questions were answered. Students around the world are challenged to creating a new world record! Find out more here.

How does your SLT develop and sustain the maths department? The NCETM has put together seven case studies here.
If any of the issues raised feel familiar, why not take a copy along to your next line management meeting?

Have you booked your place on the **Excellence in Mathematics Leadership** event on the 3 April? This national event aims to provide mathematics subject leaders and aspiring leaders with practical advice, guidance and resources that can be used in school to boost the leadership of the mathematics team. The NCETM Excellence in Mathematics Leadership resource will also be launched. Book your free place here.

It's World Book Day on 5 March so make sure that you make time to sit back and relax with your favourite author.

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Diary of a subject leader

Real issues in the life of a fictional Subject Leader

Last week I was feeling somewhat guilty. While sorting through the mess within my desk drawers, I came across the Bowland Maths DVD which had been handed to us at the last subject leaders' meeting. At the time, it was like many other free resources – conveniently filed away and forgotten about. That was now months ago and I'm left kicking myself as to why I hadn't taken the time to look at it in more detail.

Since the launch of the new Programme of Study and with Functional Skills looming on the horizon, the maths team has been scratching their heads as to how to implement the Key Processes within lessons. Sure, we had written rich tasks and incorporated them into our scheme of work but I knew deep down any pedagogical change would be slow. So, was the Bowland disc another stepping stone toward making it happen?

The resource is vast and was initially somewhat overwhelming. However, having invested time in reading the explanatory notes, navigating my way through the materials became increasingly straightforward. The Case Studies looked exciting and would certainly be used. Nevertheless, as head of department, I was more intrigued with the five Professional Development Modules. These are designed to support teachers with the challenge of teaching investigative, non-routine, problem-solving activities. Each is centred on 'an activity', backed up with handouts, film clips and suggestions. Consideration is given to planning, teaching and reviewing, with the focus being on the promotion of the Key Processes within lessons.

To share good practice and promote CPD within the department, we are each to investigate one of the Professional Development Modules for use within future meetings. In addition, the Case Studies have been shared among us to trial at some stage. Already initial feedback on these has varied, however some look very interesting and I'm looking forward to seeing how both students and teachers take to them.

I'm now left wondering what else has been filed away which may be of use. What exactly is in all of those National Strategy folders…?