Secondary Magazine
Issue 22

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 22 of the Secondary Magazine. We hope everyone is refreshed after the half-term break. It's hard to accept that Christmas is on the horizon so we will all be glad to have some real mathematical meat to take our minds off it! We hope the new format continues to be popular, and thank you for all your positive comments.

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Public perceptions of mathematics

During a recent visit to a university's ITT department, I noticed a number of large sheets of sugar paper with the words "Maths is…" followed by an assortment of felt-tipped definitions. This was, it turns out, an opening activity for the mathematics PGCE students to work on. It got me thinking about the public perception of mathematics. It might be worth trying the exercise yourself before reading on. Jot down the rest of the sentence *maths is*…

Now put yourself in your students' shoes (or give the task to your students!) and try again. What would they say? What would your non-mathematical friends say? What do you make of this discussion in the Maths Café community?

The (mis)perception that mathematics is about number crunching is hard to avoid. Stories in the media range from percentages to negative numbers but almost every story with a mathematical theme relates to, what is essentially, calculation (there are, of course, also the 'hard maths' stories where mathematicians develop a difficult looking formula for, say, the perfect head on a pint of beer or bacon butty).

The focus on calculation is surely comparable to saying that English lessons are all about spelling or that geography is simply a matter of knowing the names of capital cities. Of course, there is a body of mathematical knowledge and techniques that it is useful to be able to recall, but isn't mathematics also how this knowledge is used when tackling a problem?

Dictionary.com defines mathematics as *the systematic treatment of magnitude, relationships between figures and forms, and relations between quantities expressed symbolically* and the QCA states that *Mathematics is a creative discipline. The language of mathematics is international. The subject transcends cultural boundaries and its importance is universally recognised. Mathematics has developed over time as a means of solving problems and also for its own sake. Mathematics can stimulate moments of pleasure and wonder when pupils solve a problem for the first time, discover a more elegant solution, or notice hidden connections. Pupils develop their knowledge and understanding of mathematics through practical activities, exploration and discussion, learning to talk about their methods and explain their reasoning.*

These are grand statements for what many people might define as doing sums!

So why is it that the public perception of mathematics is so narrow? Is it simply the majority of the population's collective memory of lessons spent chanting times-tables and working through pages of identikit exercises where the only difference in each question is that the numbers have changed?

Hoffman (1989) points out that what the teacher thinks mathematics is will shape the kinds of mathematical environment they create – and thus the kind of mathematical understandings that their students develop.

All too often, I find myself leaning towards what I think of as the AA routefinder approach to mathematics (with printed instructions telling me to do this then when you've done it, do this…) rather than the Google Earth approach (in which I get to see much, much more and have to decide on the best route myself). If all I'm interested in is getting to my destination (or answer) then I know which one of these feels most efficient.

But I don't want my students to have the narrow, Sat Nav view of mathematics that seems to be so prevalent. I want them to think of mathematics as more than number-crunching. Maybe the new curriculum will go some way to helping me address this. The emphasis on a problem solving approach could mean that the mathematical environment that we create, that our students of all levels experience, will help them to develop their own mathematical map and to see for themselves the links and connections.

A while ago my department worked through a couple of the NCETM department workshops – Why do we teach mathematics? and Learning mathematics in my school. Maybe now, early in the academic year, is a good time to revisit these, to ask ourselves what it is that we believe we're actually teaching our students and what it is that they think they're learning.

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. The credit crunch and its implications for savers has been in the news almost constantly for the last month or two.

This resource looks at a way of beating the credit crunch by following the example of a couple who sold their house in 2004 and invested in gold. Did they do the right thing or, with the benefit of perfect hindsight, can you and your students do better? What strategy of shifting investments will make the most profit out of the price of an average house?

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 new Key Stage 3 programme of study.

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

The Interview

Name: John Mason

About you: Currently I am paid as Professor of Mathematics Education at the Open University, but I am also (unpaid) Senior Research Fellow at the Department of Education at Oxford and Visiting Fellow at Linacre College. I have been at the Open University since 1970, and am due to be retired in 2009. I started teaching mathematics at the age of 15 and have been trying to help people ever since. I have written or co-written some 20 books and some 275 articles and chapters of books in mathematics education, and contributed to the writing of at least 10 OU courses. One of the most enjoyable experiences was designing some of the OU summer schools. I am still amazed to meet people who claim to have been influenced by our courses and books. I particularly enjoy working with people who want to work on pedagogical issues in mathematics, such as at the annual Institute for Mathematical Pedagogy that my wife Anne Watson, Malcolm Swan and I run each summer.

The most recent use of mathematics in your job was... working on a problem last night as I went to sleep, about pecking orders among chickens, also known as tournaments.

Some mathematics that amazed you is... how there are themes which pervade mathematics (such as doing and undoing, and invariance in the midst of change) and how these typify how mathematicians work. For example, solving a problem about tetrahedra using both group theory and polynomials.

Why mathematics? Cynically, it was the subject that I did best in, and required least effort to do well; actually, working on mathematical problems and contemplating deep questions such as 'what is the sense and purpose of human existence?', is what gets me up in the morning.

Your favourite/most significant mathematics-related anecdote is… perhaps clapping in the middle of a lecture on tensor algebra when a particularly beautiful theorem was proved (I was the only one who clapped!).

A mathematics joke that makes you laugh is… (the truncated version) after Noah had told the pairs of animals to "go forth and multiply", he went round to see how they were doing. They all seemed to be procreating except for two snakes. He puzzled over this for a long time, and finally realised what was needed, so he chopped down a tree and cut it into logs. Why? Because adders need logs to multiply.

Something else that makes you laugh is… the delight I experience when someone, me or someone else, suddenly sees with clarity the essence of a problem or a concept (this is the root meaning of 'theorem', from 'theorein', meaning 'to see').

Your favourite television programme is… subtle detective series; programmes like *The Choir* and *Maestro* in which people make use of hidden talents to succeed at daunting challenges.

Your favourite ice-cream flavour is… I like as wide a choice as possible so that I can then choose strawberry.

Who inspired you? My high school teacher Geoff Steel, the mathematician-educator George Pólya (through his film *Let Us Teach Guessing*) and J. G. Bennett (philosopher, mathematician and seeker).

Focus on...probability

The origins of probability theory are usually traced to the 1654 correspondence between Pascal and Fermat, *Les Lettres de Blaise Pascal*. Probability (or *probabilité*) does not figure in the letters and the only word a modern reader might want to translate as probability is *le hasard*, used by Fermat in his letter of 25 September: "*La somme des hasards... ce qui fait en tout 17/27*." Probably the first use of *Probability* in its modern sense is used in the last chapter of *La Logique, ou L'Art de Penser* (1682) by Pascal's friends Arnauld and Nicole.

The word *kans* (chance) was used repeatedly by Huygens in his Dutch work *Van Rekeningh in Spelen van Geluck*. Here chances are possibilities or opportunities: e.g. "If the number of Chances I have to gain *a*, be *p*, and the number of Chances I have to gain *b*, be *q*. Supposing the Chances be equal; my Expectation will then be worth *ap+bq / p+q*." The expression "chances are equal," which is used a lot, means that the probabilities of the opportunities are the same. The word *probability* appears once in the expression "more probability" and once in "equal probability".

The term "probability" featured heavily in De Moivre's *The Doctrine of Chances: or, a Method of Calculating the Probability of Events in Play* (1718). De Moivre uses "probability" in its modern sense, e.g. "To find the Probability of throwing an Ace in two throws of one Die." The book's opening proposition connects *chance* and *probability*: "The Probability of an Event is greater or less, according to the number of Chances by which it may happen, compared with the whole number of Chances by which it may happen or fail." Chances are counted and probabilities are derived from them.

Suppose you're on a game show, and you're given the choice of three doors. Behind one door is a car, behind the others, goats. You pick a door, say #1, and the host, who knows what's behind the doors, opens another door, say #3, which has a goat. He says to you, "Do you want to pick door #2?" Is it to your advantage to switch your choice of doors? When this *Monty Hall Problem* (named after a game show host) and the solution appeared in the magazine *Parade* in 1990, approximately 10 000 readers, including nearly 1 000 with Ph.D.s, wrote to the magazine claiming the published solution (that it is better to switch) was wrong. You can see the original problem and the letters provoked here.

It is known that there are an infinite number of worlds, simply because there is an infinite amount of space for them to be in it. However, not every one of them is inhabited. Therefore, there must be a finite number of inhabited worlds. Any finite number divided by infinity is as near to nothing as makes no odds, so the average population of all the planets in the Universe can be said to be zero. From this it follows that the population of the whole Universe is also zero, and that any people you may meet from time to time are merely the products of a deranged imagination. (Douglas Adams)

If 23 people are gathered in a room the probability that two of them will share the same birthday is ½. For the probability that two of them share a **specific** birthday (such as 13th February) to be ½, there need to be 253 people!

An idea for the classroom – best value

The importance statement for the new Key Stage 3 Programme of Study states that:

Mathematics is fundamental to national prosperity in providing tools for understanding science, engineering, technology and economics. It is essential in public decision-making and for participation in the knowledge economy.

So it is important that pupils can use their mathematics to work out the best value in different situations. In this issue, there are two resources which could be used in a lesson to encourage pupils to use and refine their strategies.

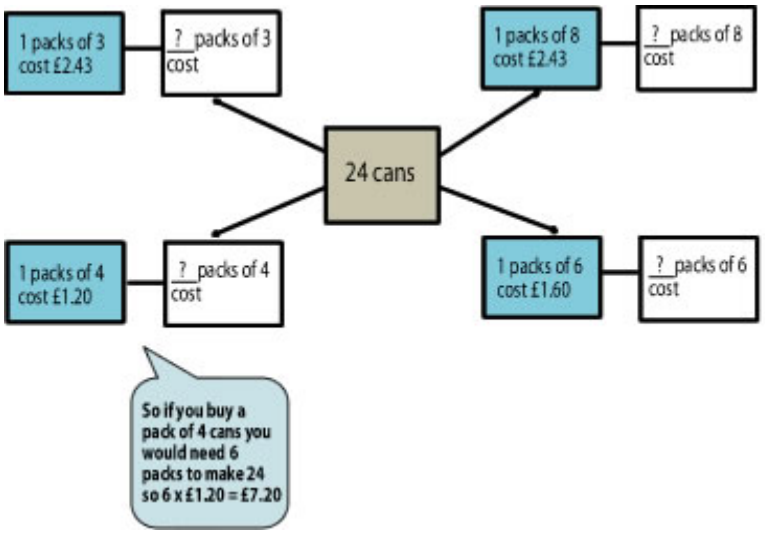
In class:

5 for £25
2 for £15
7 for £35

First there is an odd one out resource.
Pupils are given three statements. For two of the statements the value for one item is the same, and the third statement is different. The pupils' task is to identify the 'odd one out'.

Here's one set of statements where the middle statement would be the odd one out because one would cost £7.50, whereas in the other cases one would cost £5.

The other resource is a set of spider diagrams which are intended to be printed out. For each spider, pupils can use the information in the turquoise box to work out the comparative prices of the items and highlight the 'best value'.



Pupils could then work out how much can be saved by buying the 'best value' and write this as a percentage of the unit price.

Homework: Parents are often asking how they can help pupils with their mathematics, so for this topic they could look for similar situations in the supermarket (multi packs of crisps, cans of drinks, chocolate bars etc.) and work out some of the savings (or otherwise) that can be made by buying in bulk.

5 things to do this fortnight

Take a look at the NCETM Online Secondary Module
This module aims to provide starting points for you to collaborate in creating an approach to mathematics that will engage your individual learners.
Key indicators of success should include retention rate into post-16 mathematics and beyond and students' enjoyment and appreciation of mathematics. The way in which we organise mathematics learning can have a profound effect on students. In this module, we look at one way of organising the year around themes. We also follow four teachers at different points in their careers as they encourage their learners to discover mathematics through investigation. Click here to explore further.

See it, try it, teach it
The Education Show 2009, is the UK's largest showcase of educational resources of all kinds. It enables educators to see what is new, try out resources and take part in free CPD so that they can teach and manage learning more effectively. In order to enable this, the Show will focus on key themes such as:

- the core curriculum subjects of English, mathematics, science and ICT
- leadership and management
- curriculum change at all stages.

So whether you're a nursery manager, primary practitioner, secondary subject head or anyone involved in education, use this website to find all the tools you need – to help your learners learn and plan your visit to The Education Show 2009.
26 to 28 March 2009, NEC Birmingham

Have your say
Here is your opportunity to comment on matters of the moment through the ATM.

Invest some time in the Bank of England
The Bank offers a range of resources and services to build awareness and understanding of its role and functions, and of central banking more generally. For the public, there is a large range of material on why inflation matters, museum presentations and displays for all ages, and a public enquiry service.
For young people, there is material on money, prices and the economy, including an annual competition for secondary school students. Click here to find out more.

Celebrate Christmas
Planning on celebrating the end of the term with your department? Then book a venue now to avoid disappointment!

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Diary of a subject leader

Real issues in the life of a fictional Subject Leader

I never cared much for the old three tier exams in mathematics. I used to question why we were the only subject who did this; the only subject who denied some students the chance of attaining a grade C at GCSE by entering them for the Foundation tier. As a result, I welcomed the scrapping of the old Intermediate exam and the widening of the range of available grades in the Higher and Foundation papers. With hindsight, was I wrong to do so?

To me, it was going to be like going back to my school days. Then you were either entered for O'level or CSE, both of which allowed students the potential of leaving school with a grade C or equivalent. The new two tier GCSE was merely stepping back to the days of mullet hair cuts, drainpipe trousers and shoulder pads. Well, academically anyway.

However, it soon became apparent that tough decisions had to be made with the C/D borderline students. Are they Higher or Foundation students? Do you take a risk or do you play safe? In the old days, if you fell into this category you were entered for both O'level and CSE, providing you with the best of both worlds, i.e. an opportunity to excel together with a potential safety net. As we know, GCSE isn't as accommodating and you must make a decision one way or the other. The exam boards do their best, however, they can only provide recommendations based upon cohorts and not individuals. Perhaps Terry in set 11c3 has the potential of pulling it off when the pressure's on?

After analysis of the results, I feel we got the tier of entry right for the majority. On the whole, our borderline students did well with a significant number gaining that illusive grade C. I do believe however, that it wasn't a fluke. Each targeted student was considered individually; their target grade, past attainment, work ethic, resourcefulness and commitment to their studies was taken into account. In addition, so were their needs, i.e. would a C grade suffice and allow them to pursue their ambitions after leaving the school?

It's not just about playing the game of tweaking procedures and the final intervention strategies which make that small, yet ever so important, difference of the A* to C figures. It's about ensuring that the curriculum taught is suitable to the students, providing them with sufficient challenge for them to progress without denting their confidence. I try desperately to encourage my staff to carefully consider the objectives taught, consider the students' prior knowledge and most importantly, adjust their teaching in accordance to their assessment of the learning taking place. The only teachers I allow to take on these key classes are the ones whom I believe have these necessary skills. Without all of this, exam entries become pot luck.

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