

Magic in maths Successful practice

Has your class caught the buzz?

Many teachers share a genuine love of their subject – but how should they go about getting this sense of wonder across to learners?

Victoria Neumark

For the national centre's Jane Imrie, "maths is intrinsically enjoyable, and the more teachers engage learners in thinking and discussing, the more enjoyable it is. It's more than just 'fun', a description which trivialises the buzz it can give!"

The days of what Imrie calls the "triple X" approach – exposition, examples and exercises – are numbered. As Mark McCourt of the NCETM points out, in these times of 20-second attention spans and little deference, teachers have to develop new styles of teaching, not least to give a good answer to the dreaded question, "What's the point of this?"

While maths teachers like former deputy head of Windlesham House School Andrew Jeffrey will reply lyrically that "mathematics is an art, a science, a language. It underlies everything in the uni-

verse", children don't find this obvious. Yet maths does underlie much of what makes modern life tick – from traffic flows to time management, the country needs numerate citizens.

New materials for key stage 3 will reach every school next year: the charity Bowland Trust will send out 23 case studies that highlight maths in real life, from drama to engineering. New Qualifications and Curriculum Authority (QCA) programmes of study for key stages 3 and 4 came on stream at the same time. All aim at pupil engagement and enjoyment – aka fun – and urge different learning styles to develop the "toolbox" of functional skills and the creativity of problem-solving.

Karen Hancock is advanced skills teacher for mathematics at Oriol high school in Crawley. "I think maths is the most amazing thing ever and I want other people to think that," she says. To share this excitement, she varies teaching styles, from kinesthetic activities for the less able – cubes, grids, rods – to simply placing a piece of paper with equations and no instructions in front of her most able year 10s. "One person started writing, then they all began chatting; then they realised there were pairs to match up," says Hancock.

She has amazed her students by bring-

ing in hucaps to show rotational symmetry, using stonemasons' directions to make a gothic window arch and taking them outside to stand in graph patterns in the playground. "We made linear graphs with their test results but then we took the last digits of phone numbers and house numbers to make a scattergraph. It brought home randomness."

In Hancock's class, "they never know what they're going to get next." Whatever they do, though, talking is key; the familiar classroom request for children to "work in silence" is a thing of the past.

Andrew Jeffrey has been a professional magician for 30 years and a teacher for 20; he sees a commonality between the two. "That kind of inquiry – 'Gosh, that's interesting, why does that happen?' – that you get in magic, that's what you want in maths lessons." Most important, Jeffrey believes, is "nurturing children's curiosity. We don't have to instil it, it's already there."

As maths teaching shifts towards interactive, web resources such as Cambridge

University's Nrich site come into their own. Its director, Jenny Piggott, who combines this role with coordinating the provision of the NCETM in the East of England, says: "When we began in 1997 we may have looked isolated and odd, but now we are mainstream." Each year, 3.5 million users from more than 100 countries look at 73m page impressions of more than 4,000 maths resources, free of charge.

Like the NCETM's Imrie, Piggott bristles at the "fun and games" tag. Yet as Rob Eastaway, chair of the Mathematical Association and best-selling author of *Why Do Buses Come in Threes?*, says: "Puzzles are often dismissed as trivial. Yet good puzzles have solutions that come from surprising places – from mathematical creativity."

Once the "dullness and grind" of the curriculum is removed, says Eastaway, people enjoy problem-solving. Figures bear him out. The UK Mathematics Trust runs challenges for 500,000 secondary-school pupils each year; Maths Inspiration workshops pack "ordinary kids aged 15 to 17" in at 500

a go; and the Further Maths Network has helped boost the number of pupils studying further mathematics: up 37.6% at A-level and 86.6% at AS-level since 2004.

Adrian Pinel runs the mathematics postgraduate certificate in education at the University of Chichester. He says that to win its students, maths has to become a critical thinking activity at early ages. Teachers must abandon the "heads-down" classroom philosophy – and student teachers must learn more innovative teaching styles. He gives the example of a question with which to provoke a class: "There are 26 sheep and 26 goats on a boat. How old is the captain?" Lots of laughter on the way to learning.

Weblinks

Nrich: nrich.maths.org
The UK Mathematics Trust: mathcomp.leeds.ac.uk
Maths Inspiration: mathsinspiration.com
Further Maths Network: fmmnetwork.org.uk



Shaping up: innovative teaching styles help add extra fizz to maths lessons at Oriol high school, Crawley Andrew Haddon

Gamlingay 'If they enjoy it, they're keen to learn'

Fran Watson's classroom is as zippy as she is. The walls are hung with messages coded in geometric shapes for her pupils to decipher (sample: "maths rocks"); a huge map of the London underground as a prompt for a variety of problem-solving exercises; origami stacking cubes adorning the cupboard. A busy knot of boys and girls are comparing the level they've got to in the online game Bloxorz, which requires cuboids rotating in a plane to go through different holes.

"There's something in maths for everyone," says Watson. "You're a better teacher and a better learner if everyone is enjoying it."

At Gamlingay village college, Cambridgeshire, where Watson is the numeracy coordinator and an advanced



Cuboid culture: Gamlingay students interacting with maths David Rose

skills teacher, 202 children aged 9-13 embody her belief that "the more they enjoy it, the keener they are to learn".

Whether year 8 are learning their times tables to music, using a marine-style chant as they march and respond to the seven times table or year 6 are busily kicking off the day with silent sums, using sign language for their mental arithmetic, maths at Gamlingay is full of gleeful teacher-pupil interaction. They might be analysing a news graphic to see where the maths was faulty or signing up for the Friday puzzle club, but they are always learning.

Out of school, high achievers go to Royal Institution masterclasses, compete in national maths challenges or go to the Saturday Maths sessions organised by a committee of local teachers. A maths trail for key stage 3 in Cambridge highlights geometry in the environment, from gothic windows to sundials. One group went to Cambridge to see the Queen open the Centre for Mathematical Sciences and to use some of the Nrich Hands on Maths roadshow resources that can be taken out to schools. They were demonstrating Aunt's Tea Cups, a 4x4 array puzzle, that is like a mini sudoku. "Is it very complicated?" asked Her Majesty. "Yes, very complicated," replied a confident year 7. "Would you like me to show you?"

Watson says: "To be honest, I am a bit of a maths nerd. Occasionally in maths a kid looks as interested and excited as I do, and I think that's great." VN

Web of fresh thinking Now there's an idea...

The national centre's wiki provides maths teachers with a place to share ideas and explore teaching methods

Victoria Neumark

In March something new appeared on the centre's website. Mathemepedia is a wiki, a website that allows users to add, remove, edit and change content quickly and easily, specifically for maths teachers. Currently there are nearly 270 entries, with groups including: mathematical concepts, pedagogic constructs, didactic devices and professional development. The most popular, visited 1,876 times and with seven amendments, is "A lesson without the opportunity for learners to generalise (mathematically) is not a mathematics lesson".

David Miller, senior lecturer in education at Keele University and secretary of the Association of Secondary Mathematics Teachers, has written a mathemepedia entry on interactive whiteboards entitled "At the board, on the desk, in the head". He visits the site regularly. "I use it as part of my CPD with student teachers. You can see different approaches to problems. It is

helpful for people new to teaching because it has examples of research, case studies and references."

Cherril Moseley, numeracy coordinator at Bignold primary school, Norwich, has co-written a lively, challenging piece. "Looking forwards, thinking backwards" calls for primary maths teachers not to teach anything that children will have to unlearn later. For example, not to say "multiplying makes things bigger", because, of course, multiplying by fractions makes things smaller. Likewise, not to say that taking a larger number from a smaller number is impossible. Instead, by teaching families of numbers instead of limited rules, Moseley suggests that young children can recognise relations between symbols.

Moseley was inspired to make an entry by "Never wrong on the first time" (viewed 921 times), which "reminded me to look at mistakes more positively". With her physics degree, she feels keenly that maths teachers, as much at primary as at secondary level, need to keep up to date with accurate subject knowledge. Mathemepedia provides a secure space for teachers to do just that.

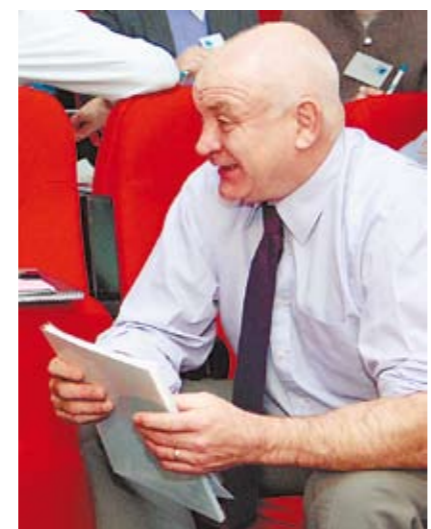
Weblink

NCETM mathemepedia: ncetm.org.uk/mathemepedia

A small grants scheme for innovative ideas aims to 'kill the deadly boring teaching of the past'

Victoria Neumark

Teacher research is high on everyone's agenda. And Colin Matthews, executive director of the national centre, says: "Teachers' great ideas strike a chord with other teachers." Putting its money where its mouth is, the NCETM Small Grants Scheme is backing those grassroots ideas and hunches that teachers enjoy sharing. Since 2006, more than 50 projects for teachers collaborating on innovative approaches to learning have been approved, a total of over £350,000. Successful practice has to move from the anecdotal to the accredited, says Matthews. That's why each approved project is peer-reviewed and supervised by an evaluator working in higher education. Each year, up to 30 small grants in the region of £3,000-5,000 are made for projects to be completed within 15 months. As well as demonstrating practical results in school, teachers have to spread the word on new,



Colin Matthews: 'Teachers' great ideas strike a chord with other teachers'

improved practice through video diaries, blogs or articles and by reporting on the NCETM portal.

The aim, says Matthews, is no less than "killing the deadly boring teaching of the past". For Snezana Lawrence, who teaches maths in Kent, the grant funded teaching cover while she ran a key stage 3 collaborative learning project. Team-

teaching shape and space in a historical context allowed pupils to engage in discussion without unlearning. Questions like "how did algebra develop?" and "how necessary are Euclid's Elements?" could be examined in small groups using Geometer Sketchpad software. Gifted and talented pupils even examined non-Euclidean geometry. When it came to sharing their work in a plenary, pupils could display their geometric animations on the whiteboard.

The centre also offers two large grants of up to £25,000 each year for projects completed within 24 months. These have to be reported in a longer report at a major conference as well as on the NCETM portal. Recently, Portsmouth match-funded an NCETM grant, using local expertise to deliver a teaching programme based on materials, research and ideas on the portal. It's been a great success, linked this year to a 5% jump in exam results and, says Matthews, "We are chuffed to bits to be associated with it."

The deadline for the next grants round is December 14: visit the NCETM website (ncetm.org.uk) and search for small grants. A summary of the conference in Birmingham on November 20 includes a report of Oxford professor Terezinha Nunes' work on teaching fractions

Magic in maths Technology

Teaching taken to another dimension

New technology can help maths teachers bring their lessons to life, making learning more interactive and engaging

George Cole

There was a time, when if you had told students that maths could be exciting, they would have looked at you as if you had two heads. But as David Holden, head of maths at Chatham grammar school for girls in Medway, Kent, says, ICT has transformed maths teaching and learning: "Maths had an image problem – 'come in, open your books and answer these questions' – but now we can use ICT to get the pupils more involved. They feel they have some ownership of their learning and it helps get them more engaged. It can help pupils understand and learn concepts more clearly. For example, if you're discussing rotation, you can show them an animated example on a computer or an interactive whiteboard."

There are many new and exciting maths software packages out there, but as Adrian Oldknow, emeritus professor of mathematics and computing education at the University of Chichester, says: "ICT is not penetrating in maths as fast as other subjects." Oldknow says that around 20% of maths teachers are using ICT as a regular part of their teaching and that is largely down to the way the curriculum is structured.

Instant feedback

It's a shame, because as Oldknow says: "ICT brings maths to life. It offers a kinesthetic approach to learning and gives students instant feedback." One of the great things about maths software is the level of interactivity it offers, he says: "You can build things, play with the software and experiment – it's like going to the Science Museum and pressing the buttons on an interactive exhibit." Holden adds: "Software like Virtual Image engages pupils. They get on-screen help and the software won't let them move on until they get it right. It's differentiated, so it caters for individual students. That's the power you can get from using ICT in the classroom." Oldknow is enthusiastic about a number of recent developments, includ-

ing the new RM Asus miniBook computer, a low-cost mobile device (it costs less than £200): "It looks like we can expect a radical change in power, weight, ruggedness, battery power and price," he says. Texas Instruments (TI) is launching its new TI-Nspire educational technology platform this month, which is designed to run on three different platforms – a handheld learning device developed by TI, interactive whiteboard and a desktop computer. It will be possible to exchange documents between, say, a PC and a handheld device, or between two handhelds.

The software will consist of seven offerings, including a spreadsheet, dynamic geometry package and statistics. "We've worked with 14 pilot classrooms and kids who didn't enjoy maths but now find maths fun," says Andrea

Forbes, Texas Instrument's education technology group manager.

Celia Hoyles, professor of education at the Institute of Education and director of the NCETM, says: "ICT has enormous potential for narrowing the gap between those who think they're good at maths and those who think they aren't. It makes maths more exciting if you can try things out and get feedback – there's huge potential for making maths more experimental."

More democratic

In fact, the national centre will be hosting a national conference to explore the potential of ICT in mathematics, teaching and learning. It will take place on March 12 2008 and look at how teachers are using ICT to engage students in maths lessons. One of the speakers will be Professor Jeremy Roschelle, director of the Centre for Technology in Learning at SRI International, an independent nonprofit research and development organisation, in Palo Alto, California, who will be discussing some of his results from his Sim-Cal research project. "ICT can encourage kids to learn more advanced maths and open up maths to more people," he says. "It makes maths more democratic."

Roschelle will also describe how ICT allows students to construct graphs and create stories around the results: "My cheetah is running at a constant speed, while your cheetah ran faster but then had to stop and go back to the start." The powerful thing about using ICT, he adds, is that "maths is not just about teachers telling kids information. Students can discover things for themselves."

Celia Hoyles is convinced that as more maths teachers discover the potential of ICT, so more maths lessons will incorporate it. "At the moment, you've got an enthusiastic group of people, but the message is spreading. It's like email – not so long ago, it was something that was new and exotic. Now almost everyone uses it. We're not quite there yet with maths and ICT, but that day is getting closer."

Weblinks

Adrian Oldknow's site: adrianoldknow.org.uk
Virtual Image: virtualimage.co.uk
NCETM: ncetm.org.uk
RM: rm.com
SRI: math.sri.com
Texas Instruments: education.ti.com

'Students feel they have some ownership of their learning and it helps get them more engaged'

The student 'I can't imagine not using a computer'



Erum Khan, 13, a student at Chatham grammar school for girls, Medway, talks about what makes a good mathematics teacher – and why computers are great to use in maths

A good maths teacher is someone a pupil can relate to – if you were stuck on something, you wouldn't be afraid to ask them for help. A good teacher concentrates on what you have to do rather than what they want you to do. The best teachers make lessons more adventurous, including ICT, having lots of displays, using PowerPoint and letting us use different websites. This boosts pupils' confidence and make them more likely to put their hand up to answer a question.

At school, we use the My Maths site (mymaths.co.uk) – containing revision pages, games, puzzles, offline activities and ready-made maths lessons for use on an interactive whiteboard, which is great. It has games like Who Wants to be a Millionaire?, which I find very exciting. It's like being on a game show that everyone can see. We also use Excel spreadsheets and Active Book, which is an interactive book (longman.co.uk) – including interactive demonstrations.

We also do tests on computers like mental arithmetic. It's much better doing things on a computer than writing them down in a book because we're more used to using a computer and, if you make a mistake or want to change something, you can do it much more easily on a computer. I can't imagine not doing my work on a computer. We also use Bitesize (bbc.co.uk/schools/gcsebitesize) for revision. It's useful, although we use My Maths more often.

The Smart Board (smarttech.com) – an interactive whiteboard is a good invention because, sometimes, you can be asked to come up to the board to show your answer. It helps the pupil's self-confidence by doing that in front of others and your teacher. I also use a computer at home to do some of my maths work. I use My Maths and it's very easy to use at home – I just log on. Even when you haven't got a teacher to help, you can still do the work.

Interview by George Cole

The KS3 teacher 'They don't realise they're doing work'



Heather Massey, a KS3 maths coordinator at Angermerring school, an 11-18 school in West Sussex with more than 1,500 students, explains how ICT can boost learning and teaching in mathematics

You've got to keep a balance of teaching and learning styles – it's not all about using computers. Open-ended software, such as spreadsheets and graph plotting packages like Autograph (autograph-math.com), allow students to enter their own data and see the results presented in a table or graph. They're very good for motivating students. Boys especially get very enthusiastic and don't realise that they're doing work.

PowerPoint can provide dynamic presentations and students can save the presentation on a memory stick or have it emailed to them to study at their leisure.

I'm also a fan of BBC Bitesize (bbc.co.uk/schools/gcsebitesize), an online service that offers a series of revision activities for students. Many of our pupils use the Maths Watch revision CD, developed by maths teacher Ken Smith (mathswatch.co.uk). The disc costs £3 and contains around 140 video and animation clips that help pupils understand a variety of topics and concepts – the kids love it. It's like having a maths teacher at home with you – very useful for revision.

I also like using a video projector and board or an interactive whiteboard. It's more interesting for students and a more interactive way of teaching.

The internet has lots of useful websites, such as Revver (revver.com), which, like YouTube, hosts vast numbers of video clips. Maths teachers at Millais school in Horsham, West Sussex, have posted more than 150 clips of work they've done on an interactive whiteboard, such as multiplying decimals or understanding indices. The clip shows the teacher working through a concept, along with an audio explanation (one.revver.com/accounts/show/millaismillais).

The Mathematics website (mathletics.co.uk) gives pupils the opportunity to pit their maths knowledge and skills against other students across the world. They get very enthusiastic and, if you choose your time carefully, you can get your class to compete with students in the US or China.

Interview by George Cole

The FE teacher 'Students thrive on variety and it can make a lesson just fly'



Kelly Hughes is a professional tutor and a Mathematics Subject Learning coach at Darlington College

I'm not a talk-and-chalk teacher, although PowerPoint can be handy to use with an interactive whiteboard. None of my lessons are the same – there's a lot of variety in the way I teach and ICT helps me do this. Students thrive on variety and it can make a lesson just fly, because the students are not just looking at worksheets or books.

The internet is fantastic and there are lots of terrific resources out there to use – you don't need to produce anything yourself. One of my favourite websites is My Maths (mymaths.co.uk), which has lots of great things to use with an interactive whiteboard. There are also online calculators, which are just brilliant to use.

I also like BBC Skillswise (bbc.co.uk/skillswise).

co.uk/skillswise) and BBC Bitesize (bbc.co.uk/schools/gcsebitesize) – both sites have lots of games, quizzes and activities.

One of the things I like doing with them is a version of the Weakest Link, where students use miniature whiteboards to write down their answers and then display them to the group.

I've recently found another system that is even better. It's called Quizdom (quizdom.com) and it's an interactive voting system. I can put together a set of questions and answers and then test the group. Each student has their own interactive response pad, and the questions can be varied, for instance, requiring a yes/no, multiple choice or written answer. The great thing is that everyone gets to answer the question and all answers are given in private – only I know how everyone has responded. The students love using it and it works well whether the student is 16 or 60. It also

helps me see which parts of the lesson I need to reinforce by the number of people who get the correct answer.

I also love using Easiteach Maths (easiteach.co.uk), because it's got things like virtual proctors. Normally, when you're teaching a class how to use a protractor, you have to do it on a one-to-one basis, but with Easiteach, I can demonstrate to the whole group at the same time. There are lots of excellent CD-ROMs around and one of the best is the Equalskills disc (tinyurl.com/28xfqz), which is an e-learning package. I used this with a student who had special learning needs and it helped her learn the basics of using a computer such as using a mouse, clicking on things and sending email (with some support). I couldn't teach without ICT and I've got a little laptop that I take everywhere with me – I hardly ever use text books."

Interview by George Cole