

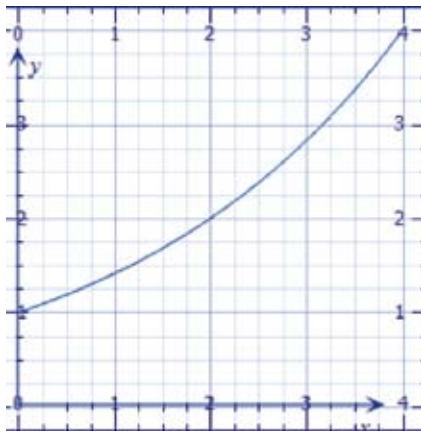
Teaching maths with ICT

Professor **Adrian Oldknow** was commissioned by Beta to produce a series of articles about using ICT in subject teaching. After researching maths teaching in schools around the country, he shares his advice on the best software, the best kit and the best lesson plans.

How times are changing. It's now about 30 years since the chip first arrived on the consumer market. In many ways it has revolutionized our lives. But it brought with it the issue of the digital divide – not least in education.

At that Hand-held Learning conference in 2007, RM announced the first Asus e-book for schools at under £200. It was also the same year that laptop computer sales first exceeded desktops. According to Intel's co-founder, Gordon E. Moore, the performance of chips is doubling every 2 years. The latest Intel Atom processors continue that trend in the new range of rugged personal sub-notebook computers running Windows XP. These Classmate PCs are designed for education within the: "One laptop per child" ethos in mind.

The current top of the range model is a tablet PC with 60 GB hard-drive costing around £320. Wireless broadband connections are now becoming much more widely available; webcams are commonplace. Microsoft has recently reduced prices significantly for Windows XP Home. They have also introduced a free plug-in tool for Word 2007 called Microsoft Math.



A Microsoft Math graph of $y = 2^{x/2}$

So, the good news is that we can look forward to more powerful, personal and affordable platforms which will run the existing range of educational and mathematical software. These platforms will also fulfil students' needs for social networking, internet surfing, video-editing and music downloading. The challenge for teachers will be to grasp the opportunity – and to use this kit to engage learners in doing, and enjoying, maths!

1. ICT technology for teaching maths

It's safe to say that almost any teacher who needs to use a laptop and video projector for a lesson now has access to both – and probably an internet connection and interactive whiteboard as well.

Most schools also now have learning platforms that can be accessed from home. Ofsted reports on mathematics teaching point to the improvements that have been seen in teachers' ability to use ICT to support their teaching and organisation.

However, there is probably less hands-on use of ICT by individuals or pairs of learners in mathematics lessons than at any time over the past 20 years. That's why Beta have done research with the Association of Teachers of Mathematics (ATM) and the Mathematical Association (MA) on "ICT and hard-to-teach mathematics".

We have been fortunate to work with a number of teachers taking innovative approaches in engaging their students in mathematics using ICT. A number of these provided hands-on workshops for teachers attending an MA conference at the British Library on May 22nd. Three of these teachers, and their classes, are featured on Teachers TV: teachers.tv/video/29853.

One teacher, Ruth, is using dynamic geometry software (the Geometer's Sketchpad) both with an IWB and with students working on PCs for work on circle theorems. Another, Jay, is using hand-held TI-Nspire units together with software on PC for work on quadratic function. The third, Aishling, is using Cabri 3D with an IWB and laptops for work on 3D geometry.

Further references to these teachers' work can be found at the following links:

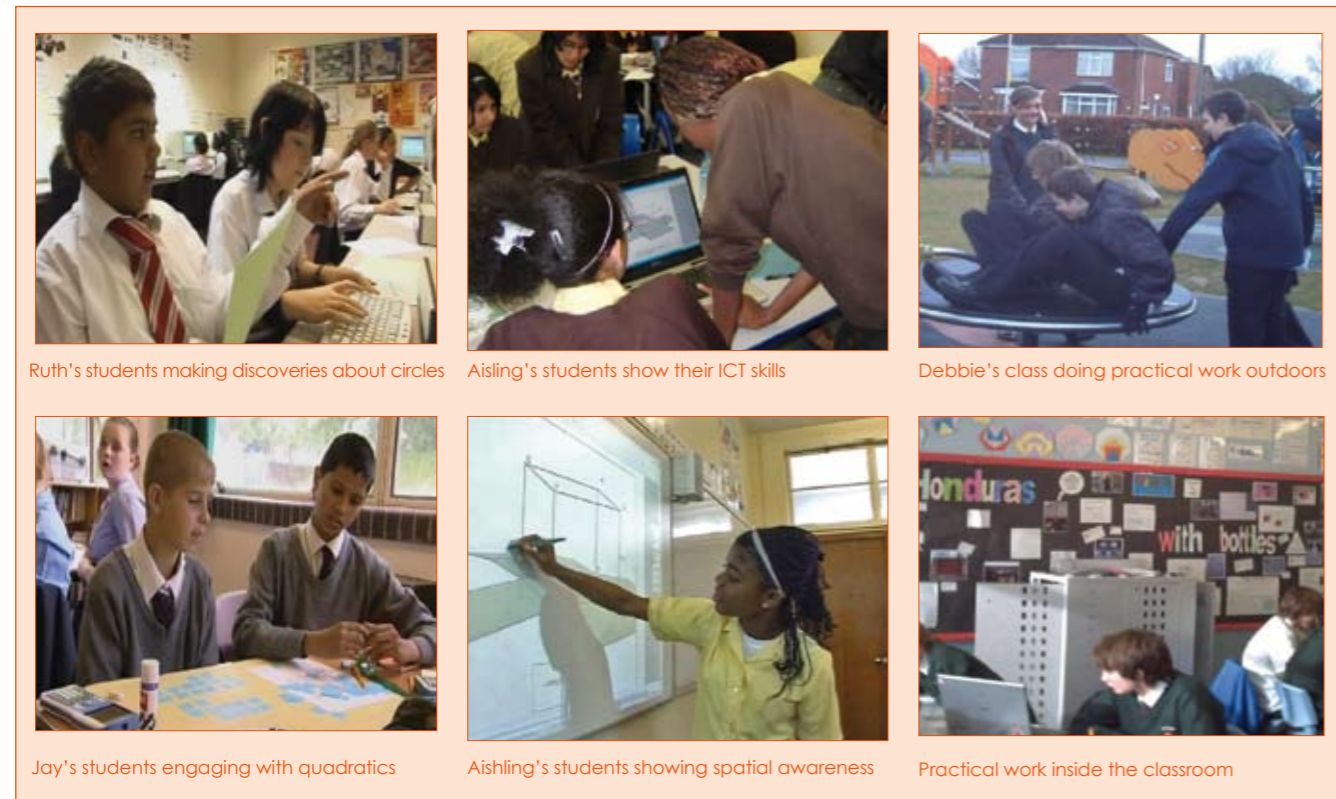
Ruth: atm.org.uk/mt/archive/mt214files/ATM-MT-214-30-32.pdf
schools.becta.org.uk/index.php?section=cu&catcode=ss_cu_ac_mat_03&rid=16345

Jay: atm.org.uk/mt/archive/mt213.html
guardian.co.uk/resource/maths-ict-resources

Aishling: guardian.co.uk/resource/geometry
schools.becta.org.uk/index.php?section=cu&catcode=ss_cu_ac_mat_03&rid=16343



An Intel Atom powered Classmate tablet



Ruth's students making discoveries about circles

Aisling's students show their ICT skills

Debbie's class doing practical work outdoors

Jay's students engaging with quadratics

Aishling's students showing spatial awareness

Practical work inside the classroom

2. We have the technology - but what about the software?

There is an extensive range of powerful mathematical software currently available. Most maths teachers will have heard of Excel, Autograph, Omnigraph, Cabri and Sketchpad. A comprehensive review of such software can be found in the Mathematical Association's ICT and Mathematics: a guide to learning and teaching mathematics

known resource is the 'Practical Support Pack: Learning and Teaching using ICT' at: dcscf.gov.uk/psp/subject.aspx?t=2&s=10. The mathematics materials match objectives from the KS3 framework and include lesson plans, help sheets, video case studies etc. Other lesson materials commissioned by Becta are available from the MA website: m-a.org.uk/key_stage_3/dfes-ks3-lesson-support-materials.htm. This

apparatus in a children's playground as a stimulus for mathematical work supported by ICT tools such as Sketchpad and Tracker can be seen at: curriculum.qca.org.uk/key-stages-3-and-4/curriculum-in-action/casestudieslibrary/casestudies/Swings_and_roundabouts.aspx.

3. Some practical illustrations - bringing life to mathematics

Pictures as background

Images can be imported as background to Excel, Autograph, Cabri, Sketchpad and Geogebra. Several relevant articles are available from past numbers of ATM's Micromath journal.

3D software - making space tangible

Cabri 3D, Yenka and Autograph provide different interactive means of exploring space

Data-logging - if it moves, measure it

TI-84 Plus graphical calculators, TI-Nspire handhelds, TI-Nspire software and the TI-Smartview emulator all support the use of sensors and probes such as the Calculator Based Ranger (CBR). Vernier's Logger Lite and Logger Pro software and LabQuest handheld also support sensors including GoMotion! Each provides instant feedback through distance-time graphs of learners' own movements.

"We have a great chance to make mathematics cool to learn"

from: secure-server-uk.com/maccommerce/product_info.php?products_id=57

Between 2005 and 2008, schools received over £500m from the government in 'e-Learning credits' with which to purchase digital content - which often included site licences for such mathematics software. However, there was no similar scheme to ensure that teachers received time and support to learn how to use the software and how to integrate it in the curriculum.

There is also a good range of free software such as Geogebra and the MA/Intel Mathematical Toolkit, as well as modelling tools such as Tracker and Modellus. A little

also includes guidance on using Cabri II Plus, the Geometer's Sketchpad, Excel and Cabri 3D:

Further support is being provided through the National Centre for Excellence in the Teaching of Mathematics (NCETM) portal e.g. through the ICT in Mathematics community. There is also an extensive grid matching a range of ICT use to current GCSE specifications. A recent study by the QCA has resulted in the guidance document: Engaging mathematics for all learners which includes examples of ICT use: qca.org.uk/qca_22223.aspx. A case-study, including video, of teacher Debbie and her pupils using

A booklet giving ideas for data-capture and modelling can be downloaded from: ncetm.org.uk/files/414304/datacapture.pdf.

TI-Nspire - mathematical education's equivalent of Office

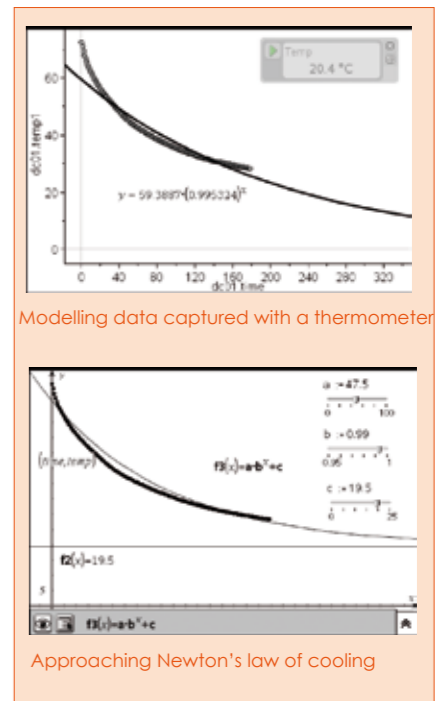
Just as 'Office' software contains a set of tools for producing documents and files of all sorts, so TI-Nspire contains in one package a complete set of tools for doing mathematics. A document can contain pages, or parts of pages, which can be for calculations, for a spreadsheet, for graphs and geometry, for data and statistics, for programming and for notes. TI-Nspire presently comes in two forms: either built-in to a hand-held device, or as software for a PC. There are also versions with symbolic computation (CAS = Computer Algebra System) and without (non-CAS). It automatically detects when a compatible sensor is attached so that data can be captured and analysed.

The free Nspire book 'Inspiring Maths in the classroom' can be downloaded from: agent4change.net/index.php?option=com_content&view=article&id=275:inspiring-maths-and-free-number-resources&catid=66:research&Itemid=182

and an evaluation report of its classroom use is available from: chiuni.ac.uk/teachered/documents/Clark-Wilson2008TI-NspireFinalReportv5.pdf. Cindy Hunt, Head of Mathematics at Davison Girls School won a prestigious award for her classroom work with Nspire: davison.w-sussex.sch.uk/?PageID=445&ParentPage=57.

5. Reasons to be cheerful!

I hope I have made the case that we already have a very good set of software tools and supporting resources to engage students working mathematically with ICT, but which are far from in regular widespread use. New developments in low-cost, portable computing devices will make it far more practicable to provide individual, personalised, hands-on access for learners. Come on - let's bridge that gap! We have a great chance to make mathematics cool to learn.



Modelling data captured with a thermometer

Approaching Newton's law of cooling

Adrian Oldknow is a regular contributor to e-learning today and Emeritus Professor of Mathematics and Computing Education at the University of Chichester. You can view more of his lesson plans at adrianoldknow.org.uk.



Geometry in Cabri with a holiday snap

Algebra in Autograph with a Problem Picture

3D geometric modelling with Cabri 3D

Exploring nets with Yenka

3D analysis with Autograph

Data capture with a CBR

TI-84 Plus graphical calculator with Go! Motion

TI-Nspire handheld with CBL2