Good Practice in the Use of ICT
In Mathematics, Science and Geography at Key Stage 3
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Editor’s Introduction: Adding value to teaching

Joyce Wood, THEO - Teachers Helping Each Other® and SPRU, University of Sussex

The project on Good Practice in the Use of ICT in Schools set out to answer this question. Teachers were our starting point. We talked to hundreds who use technology effectively. They discussed thorny areas of their subjects – the parts that are hardest to put across – and explained how technology helps. Most offered to share their approaches. This report is a result.

The teachers featured in these pages offer a range of sound, effective ideas for teaching with technology. Their examples focus on science, mathematics and geography at Key Stage 3. We chose approaches which we thought most teachers – including technical novices – could use and endorse. Crucially in each case, the teacher uses technology to achieve an important result that cannot be achieved as readily in any other way.

What difference can technology make in a classroom?

Experiments involving drawn-out processes or momentary events. Technology can track an ongoing process or capture a moment in time. It lets children trace and analyse e.g. germination or the swing of a pendulum.

Analysis of abstract concepts or invisible phenomena. Technology helps children get the picture. In mathematics, it lets children manipulate shapes to investigate their properties. In biology, it lets them “see” inside themselves, even to the molecular level.

Exercises requiring a range of visual perspectives. Technology lets users rotate or enlarge images and zoom in on their features. Digital maps let geography students change scale in an instant, from overviews of a county to features of the roads in which they live.

Repetitive tasks to gather evidence. The computer does the rote work, freeing children to focus on ideas.

Experiments that cannot be carried out safely or practicably. Using simulations and spreadsheets, students can explore relationships between speed and stopping distance, temperature and the reaction rates of volatile elements, populations of predators and prey.

Problem-solving based on trial and error. Technology helps children ask “what if” and test a myriad of options. They can make mistakes and start over without losing face, change their minds without making a mess. They can vary parameters and see the impacts at once.
Technology engages children and builds their confidence. Alison Clark-Jeavons (page 7-8) teaches algebra by stealth. Her pupils create animated pictures, unmindful that mathematics underlies their work.

The child’s finished product looks semi-professional (at least to its author), and the child takes pride in this.

Technology gives children control. They can select and adapt material readily for their own purposes. The topics they study take on a personal meaning. They can control the technology itself. In Phil Duggan’s example at pages 9-10, special-needs pupils manipulate a robotic telescope and dictate the choice of data collected.

The Internet lets children collaborate across continents. John Harris’s Metlink project (see pages 15-16) lets children round the world compare their local weather conditions and work together on related projects. You and your school are invited to join in.

Some better-known features of technology are equally significant.

The examples in this report vary widely. What they have in common is that they use technology as a tool, not an end in itself.

Two teachers explain how to make the most of a single PC. Two use friendly handheld devices. Another offers dynamic geometry without the sweat of software. Several bring in citizenship, getting children to address local problems which affect them. One takes her pupils on mathematical field trips. Yet another uses role play to help children recognise bias on websites – a life skill for the Information Age. We like to think there’s something here for everyone.

Our research on good practice has now evolved into a programme called THEO - Teachers Helping Each Other®. The teachers featured here are part of this, as are a hundred others whom we interviewed. THEO teachers will give master classes and accredited short courses under the auspices of University schools of education. They will act as mentors and advisers. Some will offer resources to BECTa’s Teacher Resource Exchange and other public websites. They will talk sense to policymakers and educational researchers. The aim is to help ensure that all teachers – and, through them, all pupils – reap the benefits of educational technology. We plan to cover all key stages and subjects and we would welcome your ideas. Please email us at goodteachers@theo.org.uk

The project has been made possible by the generosity of its sponsors. I thank them for their indispensable support, with added thanks to RM for producing this booklet. I am grateful also to members of the project working group and all the teachers who contributed.

Finally, I thank Jean Irvine OBE of the Post Office, The Lord Lewis of Newnham FRS, Dr. Jack Gow of the Science Council, Niel McLean of BECTa, Marian Brooks of Cranford Community College and John Leighfield CBE of RM for their advice and encouragement at the start.

All material which follows was first presented at the project’s March 2000 Conference on Good Practice in the Use of ICT in Schools.

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We have entered a new information revolution driven by the Internet. Its impact is breathtaking. With 19.4 million users connected to the Internet from home PCs in the UK, the Internet is rapidly becoming the gateway to opportunity in every area of modern life. We can see this on our TV screens, in our newspapers, on billboards and in magazines. Very few adverts these days are without a website address promoting opportunities in education, employment, travel, business, leisure, banking and purchase of an increasing range of goods and other services. The list gets longer and longer.

Our schools ICT policy reflects this. We are building the National Grid for Learning (NGfL), investing £1.7 billion in ICT provision and training. At a time when we have kept a tight grip on public spending overall, nevertheless the Government - the Prime Minister, the Chancellor, and Secretary of State David Blunkett - have found the political will to make these resources available in schools.

There are two dimensions to this massive investment. A majority of jobs in the UK already require some sort of interaction with IT. We must enable children to embrace all the opportunities that these technologies offer. That is the first point. We must make sure that every child leaves school fully conversant with this essential grammar of modern life.

The second point is that technology is vital to our drive to raise standards of inclusion and achievement. There are historic opportunities here. ICT is a transformational technology. It doesn’t just improve our ability to do things we have always done. It enables us to do things we couldn’t do before – in the classroom as in every other area of life. The examples in this report show teachers using ICT to put across ideas which have eluded children in the past.

What do these examples show us?

ICT can give children control of their learning. It makes them authors – in a sense – of their own learning experience. It helps them visualise abstractions. It also links them to the wider world, opening their minds and broadening their outlooks. At the same time, ICT enables teachers to intervene more effectively than hitherto.

Information is no longer the prerogative of a priesthood. Knowledge and information are being democratised. This is empowering but also profoundly challenging. Now, ever more than before, leaners must acquire conceptual skills - the ability to sift, analyse and make sense of inchoate masses of raw information, in whatever subject.
This report is about the craft of teaching with ICT — a branch of pedagogy still in its infancy. Overall, there is still no consensus about what it involves. Yet we find examples in classrooms throughout the UK. Many teachers have developed solid approaches like those in this report. I have seen inspiring examples of good practice as I visit schools up and down the country.

However, teachers who develop excellent ways of using ICT rarely share their expertise outside their own schools. They have few opportunities to do so. We need to provide these opportunities, help more teachers to produce content, engage all teachers in the process of evaluating content, and create a culture in which all of this occurs readily and naturally.

BECTa in conjunction with NGfL has been developing the Teacher Resource Exchange to give teachers an opportunity to share their own examples of good practice.

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It is crucial that teachers who are pushing the frontiers — indeed all teachers who develop sound approaches — should be enabled to share good practice with colleagues. And that’s what this report is all about.

The contributors to this report are real teachers who know how to put good content across in real classrooms. They know what works best and why. They use technology in ways which make a genuine difference to their subjects. Their approaches could be taken up by many schools now. That’s why I was pleased to learn that the teachers featured here are becoming involved in THEO, an independent, teacher-run programme to help other teachers. They will be reaching out — through short courses, master classes and mentoring schemes — to help each other with the day-to-day practicalities of harnessing technology.

This complements the Teacher Resource Exchange and fits in perfectly with the NOF training programme. We rely on schools, teachers and the private sector to work in partnership with us, developing good ideas, innovating good practice, raising standards and promoting our drive for inclusion. I welcome and appreciate the efforts being made by these talented, resourceful and generous teachers and would also like to thank the Post Office, RM, Pearson, the Ordnance Survey, Norwich Union, Marconi Communications and GlaxoSmithKline for their support.

Michael

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A key issue in the Information Age is the credibility of information sources. Students have to learn to approach the Internet critically and to consider the motives of information providers. In Year 9 at Raincliffe School, this is achieved through an eight-week project on the Amazonian rainforest.

The class is divided into four groups to prepare a multimedia debate on changes in the rainforest. Each group represents a different point of view - that of the Brazilian government, environmentalists, poor Brazilian farmers or indigenous tribal people. Typically at the start, pupils have a very black-and-white view of the issues.

Each group begins by preparing a classroom wall display promoting its viewpoint. Three lessons are used to research and prepare a PowerPoint presentation and desktop-published flyers, with various activities divided amongst the members of each group. The group meets periodically during the preparation period to plan and co-ordinate its multimedia presentation. A deadline is set and a lesson allocated for each group to make a ten-minute presentation, involving all its members. Pupils are encouraged to use books and newspapers for their research, as well as the Internet and CD ROMs in the school library. Websites are suggested but pupils are also encouraged to find their own sites.

The presentations and ensuing debate involve role play. Pupils are encouraged to dress up as the people they represent, having spent some time during the preparation period creating their outfits. Each group begins its presentation by distributing its DTP flyers to the rest of the class. These outline the key points of the group’s argument. The presentation is made in front of the group’s wall display, which is referred to during the talk.

The group uses its PowerPoint presentation as a central focus. The presentation again outlines the key points the group wishes to make. It is illustrated and animated with material from the Internet. Some groups also make their own videos, usually in a newsroom format, with ‘live’ outside broadcasts from the Amazon rainforest filmed in a wood next to the school grounds. The four presentations are followed by a class debate. This process takes four one-hour lessons in total.

The discussion and role play bring home to pupils the fact that material found on the web should not be taken at face value. They realise that the web is used by groups of people to promote their own interests and points of view, which often conflict.

After the debate, pupils are required to write an essay summarising the four viewpoints. The essays must culminate in a conclusion where the pupils explain their point of view, having analysed all the evidence. The more able students highlight the significance of sustainable development for the future of the rainforest.

Over the course of the project, they begin to see that the situation isn’t straightforward and come to appreciate the range of viewpoints involved.
In curriculum terms, the project is centred on geography, ICT and citizenship. It allows pupils to investigate the issue of changes in the Amazon rainforest from a variety of viewpoints. It develops pupils’ geographical and enquiry skills and their knowledge and understanding of environmental change and sustainable development. It provides an opportunity for pupils to develop their ICT skills in researching information and communicating to an audience.

The essay, which concludes the unit of work, is used as a major levelling assessment for geography in Year 9. It is possible for pupils to demonstrate Level 7 upwards in this task. The multimedia debate is used as a major levelling assessment for ICT in Year 9. It contributes to all four elements of the ICT programme of study. Pupils can successfully demonstrate aspects of Levels 6 and 7. Likewise, the project contributes to all the elements outlined in the Key Stage 3 Programme of Study for Citizenship. It also bridges further areas of the National Curriculum - in particular, PSMSC, Key Skills (communication, IT, working with others, problem solving, thinking skills, enterprise and entrepreneurial skills), and education for sustainable development.

The Raincliffe School website http://www.raincliffe.co.uk/ includes a collection of digital images from the most recent rainforest debate. Further information will be added during the year. To access the pupil section of the website, click on the left hand door on the image of the school entrance.

The following websites have been used by pupils in preparing their multimedia presentations:

**Brazilian Government**
The Brazilian Embassy in London website http://www.brazil.org.uk

**Environmentalists**
Rainforest Action Network http://www.ran.org

**WWF Global Network**
http://www.panda.org

**Greenpeace International**
http://www.greenpeace.org

**USGS Earthshots**
http://edcwww.cr.usgs.gov/earthshots/slow/tableofcontents

**Poor Farmers**
BBC News http://news.bbc.co.uk

**Tribal People**
Survival International http://www.survival.org.uk

Instituto Socioambiental, Brazil http://www.socioambiental.org/website/english

It also encourages knowledge, understanding and skills of citizenship, particularly implications of the world as a global community.
My Year 8 students learn to produce animated pictures on graphic calculators. The purposes of this activity are to develop students’ understanding of co-ordinates, provide a real application of algebra and develop their problem solving skills, by answering the question,

"Here is a co-ordinate picture; now how can we make it move?"

The activity uses relatively low-level, inexpensive technology and can be carried out in the classroom. Each student has a handheld graphic calculator and the teacher has a calculator Viewscreen® placed on an overhead projector. The Viewscreen® facilitates the projection of the teacher’s calculator screen for the whole class to see. It is possible to link a student’s calculator easily with the teacher’s to share an individual student’s work with the whole class.

The first task is to create a co-ordinate picture. To do this, the students input a set of co-ordinates into the statistical list facility on the calculator and set up a statistical plot. The level of difficulty can be varied here, with students entering positive/negative integers or decimals to create a picture in one, two or four quadrants.

The feedback given by the calculator display allows students to spot and amend any errors quickly and easily when producing the static picture.

The next stage of the activity is to introduce the question, “How can you make your picture move?”

The first consideration for the students is that the effect of adding a constant to (or subtracting a constant from) all the numbers in the list will alter the image in some way. The teacher is able to test and verify a student’s conjectures using the viewscreen, observed by the whole class. The whole list is manipulated by using its label. For example, L1 + 1 → L1 would increase all of the X coordinates by one and translate the image one unit to the right.

To achieve a succession of translations, the students need to write a short program with a loop to repeat an instruction.

Students are able to build several animations to produce a short film. Samantha’s animation showed the Titanic sailing towards the iceberg, hitting it and sinking.

In our school, a Texas Instruments TI83 calculator was used by teacher and students.
The four line program SINK became a subroutine within the complete program.

The subroutine DOCK stored the co-ordinates of the start position; SAIL moved the boat towards the iceberg and SAVE showed a survivor surfacing from the sunken vessel. (The sea and iceberg were drawn using the 3rd and 4th lists - L3 and L4, not shown here.)

The use of technology enriches the learning process in several ways. Students can conjecture and experiment more readily than with pencil and paper and the technology provides instant feedback.

The activity allows the introduction of algebra by the back door. The students discover that they are using algebra to manipulate the lists within their programs. The choice of animation is limited only by their imaginations. Students can explore translations, enlargements, and reflections by working out what they need to do to the lists in order to achieve an outcome. The technology speeds this process to make it a viable class activity. The students also share new ideas and strategies with each other. The possibility of linking calculators means that lists of co-ordinates, calculator settings and programmes can be buzzed from one student to another in seconds. Having designed an image, a student can then use another student’s programme to produce an animation.

Students use mathematics purposefully in this activity. They can begin to see the relevance of mathematics to the design of images they see on computer screens and they can begin to reproduce such images, albeit at a basic level.

The activity can be used to introduce programming skills to students of all ages and abilities. The immediate feedback from the calculator facilitates exploration by the students. They are able to make and evaluate their decisions in a safe (non-judgemental) environment. They have not had to commit their ideas to paper, with the possibility of being wrong.

Overall, this approach is highly motivating. The quality of work produced and the level of enjoyment experienced by the majority of students are testaments to this.
Masters of the universe - data-logging with an online telescope

This article describes the use of a robotic telescope to teach both science and data-logging at Key Stage 3. Additionally, it describes software I am developing to make this usage possible. The software has features for students with special needs. Any school wishing to use the telescope - or help develop the software - is invited to do so.

The Liverpool Telescope - the world's largest robotically controlled telescope - was designed and manufactured by an enterprise company of Liverpool John Moores University and will be operational later this year. It will be sited on La Palma in the Canary Isles, 2,400 metres above sea level on the edge of an extinct volcano. The telescope will operate autonomously, with no astronomers on site, responding to an observing schedule sent from the University over the Internet.

Image data will be produced by a sophisticated digital camera and large amounts of environmental data from the observatory site will also be made available for use by schools. The Liverpool Telescope will, in effect, act as a powerful data logging sensor, providing a wealth of opportunity to exploit in the classroom.

I am developing software to let the telescope be used in this way. There are compelling reasons. Purchasing sufficient quantities of traditional data-logging hardware can be expensive, while few science staff have the expertise to use it correctly. Current systems usually cannot be configured to address the needs of individual students and focusing enough ICT equipment in a laboratory can be a problem. Finally, data-logging can be boring and time consuming for the less able student.

The telescope will let science students carry out real data-logging using sophisticated hardware within an industrial/scientific context. The theory and application of data-logging will be studied in a configured multimedia environment with more opportunities for students to hit cross-curricular attainment targets. Students can work individually or in groups.

Part one of the software covers data-logging concepts and assessment, with reference to the Liverpool Telescope as a data-logging device. It presents data-logging within the context of space and explains the role of the Liverpool Telescope Schools Observatory (LTSO). This is essentially a self-study module, to be used at Years 8 or 9.

There are three sections:
- The Liverpool Telescope - looking at the universe around us
- The concepts and use of data-logging
- A computer-generated, automatically marked test

Excitingly, schools will be allocated observing time, with the telescope schedule accommodating their requests alongside those of professional astronomers.
Part two enables students to perform data-logging using both archived and specially requested data from the Liverpool Telescope. It is currently under production. Both parts run on either standalone or networked machines and will also link to the LTSO website to request and download data.

The software is designed to be adaptive and inclusive. Sections of the software are identified by colour, with colours chosen to avoid problems with colour blindness. Screen layout and content are kept simple, with functions in the same place on each screen. Navigation is clear and simple, with forbidden paths clearly crossed off. Only one concept is introduced on each screen. The student can control the flow of the learning experience.

Audio commentary and explanatory text help raise reading skills. A ‘SPEAK’ feature reads out text on the screen using voices of children of comparable age and background to boost pupils’ identification with the material being presented. A ‘TELL ME MORE’ feature lets the teacher easily record commentary to expand explanation of the material and link it to student experience. Different sets of commentary can be recorded for use with different classes. Explanatory text appears whenever a student clicks on a term or piece of text that may be difficult to understand.

Student interest is stimulated by the use of ‘hooks’ and story lines. One ‘hook’ in this particular case is the possibility of the Earth suffering a catastrophic collision with an asteroid or meteorite.

The material deliberately uses scientific and computer target language. The alternative of reducing the reading age of the material would drastically limit the terminology that could be used and thereby defeat the purpose of the exercise. It would also alienate the more able students. Instead, as with the use of target language in Modern Foreign Languages, the effort is made to explain terminology in sufficient detail to make it understandable.

This is not a commercial product. Any teacher who wishes to participate in the project, either personally or through their school, is very welcome. The web address of the LTSO site is: http://telescope.livjm.ac.uk/schools

Please email me with any comments or suggestions at: phil_duggan@hotmail.com

Positive reinforcement is provided for correct answers to questions.
The National Curriculum requires pupils to use particle theory to explain properties of materials and phenomena such as diffusion and changes of state. In my scheme of work, pupils start by building models (out of plasticine, marbles and square wooden blocks) and looking at crystals to establish that particles have regular shapes. I demonstrate mixing experiments to suggest that particles are spherical - and diffusion experiments to show that particles move. This practical work provides pupils with evidence of the existence and behaviour of particles but it is difficult for them to visualise any of this. This is where ICT comes into its own - certainly with my pupils.

Havelock School, where I work, is an 11-16 comprehensive with a good reputation for supporting pupils with special needs. The decline of the fishing industry has caused serious unemployment in our area. Our pupils have low aspirations as a result.

A CD ROM gets round these problems. It can use techniques like animation to put difficult ideas across. The teacher is free to repeat a particular sequence or control the order in which segments are shown.

I have been using the ‘States of Matter’ CD ROM for the last four years. It uses a cartoon chemist, ‘Yardley’, to stimulate interest and a response from the pupils. The program is designed for individual use by pupils, either on standalone computers or as part of a network. However, I use it in the same way that I would demonstrate an experiment to pupils. Pupils are arranged in rows, which are tiered, so that they can all see the single machine. Ideally, a projector could be used to enlarge what is seen.
I introduce the CD ROM after two double lessons of practical work, covering the sequence of activities described above. I use it to consolidate what the pupils have learned and to help them visualise the more difficult aspects - for example, how particles in a liquid can touch one another, yet flow. My use of the CD ROM lasts only about 5-10 minutes.

The cartoon character, Yardley, asks a variety of questions and the CD ROM can be paused while pupils respond. I also put questions of my own, referring back to the evidence from our practical work. I can link what is on the CD ROM with my pupils’ experiences.

The visual effects let pupils ‘see’ how particles behave, where previously they had to struggle to imagine this.

The CD ROM can be used again later when other difficult phenomena are encountered in practical work. Pupils can use it individually or in groups. As they have already been shown one sequence, they feel more confident in using it and are aware of what it offers.

Acknowledgement: ‘States of Matter’ published by New Media Press Ltd.
Dynamic geometry software first came to light with Cabri, Geometer’s Sketchpad and Geometry Inventor. The essential idea is that the user can construct geometric objects such as points and lines by using menu options and icons and then from these build up perpendicular or parallel lines or circles or bisectors and so on. The results can be manipulated using point and click mouse operations and any correct geometric property will remain true throughout. For example, two lines constructed as parallel will remain parallel however the points that constructed them are moved.

Brilliant software, but there are a couple of problems. On an INSET day, teachers see one package or another demonstrated, are duly impressed and spend hard-fought for capitation on a school license. But subsequently, with limited time at school, they can’t learn it or find applications or get suitable access and the software gathers virtual dust in a far corner of the school network. A second problem is illustrated by the example task, ‘Use your dynamic geometry software to construct a square’, which might have this typical solution:

1. Construct two points, A and B, and a line through them.
2. Construct lines through both points perpendicular to that line.
3. Measure the distance AB and transfer that distance to the two perpendicular lines, measured from A and B. This constructs two further points C and D.
4. The square ABCD is constructed.

Fine, problem solved. However, although undoubtedly the software is sophisticated, one issue remains. It is far more difficult for a student to learn the skills necessary to complete steps 1 to 4 than it is for them to learn what a square is! Unless sufficient curriculum time is devoted to the technological aspects of the software, and to the ideas of points and lines, parallel and perpendicular, little progress can be made in school. The software becomes used for trivial and isolated tasks that do not warrant the expense or even the limited time allocated, and at worst is not used at all. Extremely frustrating for all involved.

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The student does not need to know any technological skills relating to the software but is free to concentrate on the mathematics, and through observation of what changes and what stays the same can gain insight into the ‘squareness’ of squares. Thus the activity becomes accessible to a wide range of abilities and ages - and usable by the busy teacher.

Teachers or pupils who prefer to start from scratch - or who want it both ways - can try Cinderella (www.cinderella.de). A new and unique addition to the small collection of dynamic geometry packages, Cinderella was developed specifically for the Internet. Though both Cabri and Sketchpad have web versions, Cinderella alone can create in a web page a full dynamic mathematical exercise, complete with interactive hints, feedback and icons to increase available options.

The flexibility afforded by this interface makes it possible to create online resources to cater for a whole range of levels of user expertise.

Our original task ‘Construct a square’, rejected before due to the conceptual demands it places on students, can be re-addressed. Now the task can be presented at various levels, anywhere from an initially blank window, through to a square completed apart from one side or one vertex. Students can go on to tackle exercises like ‘construct a rhombus’, ‘reflect a triangle’, ‘rotate a square’, or even advanced tasks like “construct the centre of a rotation”. Figure 1 shows a possible implementation. You can see the three key components: the dynamic geometry screen, a window which displays hints and feedback as the task progresses, and buttons that permit the user to make further geometric constructions.

Figure 1: Construct the centre of rotation

Figure 2 shows a second example. All the labelled points can be dragged so that the user should be able to identify, by its geometric properties, what kind of quadrilateral each one is.

Figure 2: Which quadrilateral is which?

For more ideas, see my own Cinderella site at www.mathsnet.net/dynamic/cindy. A full online course in transformations is available at www.angliacampus.com
How’s the weather where you are? Join this global project!

Would your school like to collaborate with schools abroad in a web-based weather observation project? Two ongoing projects would welcome new participants.

In MetLink and Cloudwatch Europe - both run by the Geography Department at Radley College, Abingdon - students use a wide range of ICT skills to record, analyse and exchange weather observations with schools all over the world. Participating students range in age from 7 to 18. MetLink 2000 involved 85 schools in countries including Australia, Canada, South Africa, Uganda, Zambia, Zimbabwe, India, Ethiopia, Czech Republic, Finland, Norway, Sweden, Denmark, France, Switzerland, Portugal, Spain, Malta, Cyprus, Ascension Island, as well as many schools in the UK. The MetLink and Cloudwatch sites are hosted by RM’s Eduweb™ and sponsored by the Royal Meteorological Society and the Meteorological Office.

During the active phase students enter their meteorological observations onto the live web database, hosted by the Reading University Department of Meteorology. The MetLink website is updated several times each day with expert weather analysis, synoptic charts and satellite images so that students can use real-time data in the classroom. There are also electronic worksheets with animated satellite images and hotlinks to a wide variety of information sources. School weather readings are circulated via email in csv format.

During the 1999 MetLink project there were several extreme weather events reported by participating schools. Temperatures of -54°C were recorded in Sweden causing transport disruption, electricity power cuts, frozen pipes and frostbite. Temperatures plunged to a 16 year record low in Malta, with freak hailstorms. Forty five mm of rain fell in 40 minutes at Peterhouse School, Zimbabwe, causing flash floods which washed away bridges and roads. A local tornado with ball lightning and 80 kph winds hit Petersfield, Hampshire, UK. It uprooted trees, brought down electricity power lines, blocked roads and disrupted road and rail communications. Meanwhile a cyclone and thunderstorms in Madagascar caused widespread damage.

MetLink 2000 took place during the tragic period of severe flooding, damage and loss of life in Southern Africa resulting from cyclone Eline. During the same period, schools in Australia reported record high temperatures of 38°C while Canada had unexpectedly warm winter temperatures, only dropping to -11°C! Britain meanwhile suffered a typical sequence of depressions bringing cloudy, wet and miserable weather.

In the initial MetLink contact phase, teachers and students exchange information about themselves, their schools, courses, weather recording techniques and instruments. Students are directed to other useful weather websites.

Live weather satellite imagery is provided by Dundee, Reading and Nottingham Universities, the BBC Weather Centre and the UK Met Office.

A live weathercam map allows students to see exactly what the weather is like in other parts of the world.
In the latter stages of the project students had the opportunity to analyse their observations and to develop project work with the help of volunteer meteorological professionals. A wide variety of graphs, synoptic charts and maps were produced with appropriate analysis for uploading onto the MetLink website.

Cloudwatch Europe is very similar in concept to the MetLink weather project. It operated in March 2000 as part of National Science Week and involved 75 schools and more than 13,000 children throughout Europe.

The Royal Meteorological Society provided a weather analysis for each day and this was uploaded to the website along with cloud charts and information sheets. The idea behind the assignment was to encourage observation and to make pupils more aware of cloud and precipitation processes. It also supported the national curricula for Science and Geography in the UK. Apart from improving ICT skills, schools linked up with each other to learn about the geography and topography of other places in Europe and their effect on cloud formation. This made studying weather systems and patterns more relevant, interesting and enjoyable.

The MetLink project was featured at the ‘5th International Conference on School and Popular Meteorological and Oceanographic Education’ held in Melbourne, Australia in July 1999.

It is hoped that both projects will continue to develop, with the recruitment of more schools in the UK, Europe and worldwide.

To find out more [http://atschool.eduweb.co.uk/radgeog/metlink.html](http://atschool.eduweb.co.uk/radgeog/metlink.html)
A busy road running past our school provided a familiar context in which the idea of speed and its consequences could be explored. Our science department developed its own teaching units to let our pupils apply the science to a situation affecting them. Our 'Victoria Road' units are used to teach Forces and Motion at Key Stage 3, in particular speed and its measurement. The units are taught to mixed-ability groups of 30 in Year 8 but could be adapted to fit the QCA scheme 'Speeding Up' at Year 9.

The units cover eight lessons, as follows:

**Lesson 1** takes as its starting point pupils’ ideas about speed. It then explores these ideas through a range of simple laboratory-based activities. By the end of the lesson, pupils have a firm idea of the relationship between speed, distance and time.

**In lesson 2,** pupils discuss road safety and quickly raise the risk they may face from speeding cars on Victoria Road. They then discuss ways to measure the speed of the cars to see if there is a real problem. Pupils, in groups of three or four, then go out onto Victoria Road to take measurements using stop clocks. The pupils in each group will typically collect data on at least ten vehicles.

**By lesson 3,** the class has collected ‘real’ data for a minimum of 100 ‘real’ vehicles. Such a volume of data could overwhelm many pupils. At this point, however, the class is introduced to a spreadsheet package. They input their data, together with a formula for calculating the relationship between speed, distance and time, and quickly discover that the spreadsheet will do the repetitive calculations for them. They also input a formula to convert metres per second to miles per hour so that their numbers have meaning in terms of the speed limit. The pupils now save their spreadsheets.

**In lesson 4,** the pupils explore ways to present their data graphically, as specified in the National Curriculum. They try out different types of graphs and charts and can see that some convey their findings better than others. They now choose the style they prefer and present their results in graphical form.

**In lesson 5,** pupils discuss the risks posed to themselves by the vehicles. Is there a real problem? Have they obtained evidence to suggest there is? They discuss sampling techniques, evaluate the quality of their study and consider whether conclusions can be drawn from their findings. How safe is Victoria Road?
The pupils create a report aimed either at the school governors or the local authority. The report must include details of their study, its findings and their recommendations based on the evidence obtained. They learn to justify their arguments and discover the benefits of being able to copy and paste both data and graphs into their reports rather than having to reproduce them.

**Pupils complete the report in lesson 6.** They are then asked to consider how safe/dangerous it was for them when they first started at the school. This provides the focus for the pupils to design a road safety poster for use in our feeder schools. The poster, created with a DTP package, adds realism and a sense of responsibility—many pupils have younger relatives in our feeder schools.

The class follows up the project in lesson 7 with some laboratory-based investigations into forces such as friction, and their effect on motion. This allows for further development of ideas about road safety and provides an opportunity to talk about stopping distances of vehicles under different conditions. The discussion can be an eye-opener for pupils, who often have very simple ideas about how quickly vehicles can stop.

**During lesson 8,** pupils reflect on their work. They summarise their ideas on speed, forces and motion and relate these to safety on our roads.

The ICT in these units complements the science in several ways. Pupils can concentrate on evaluating their data rather than processing it manually. They can easily compare the merits of different styles of graphical presentation without having to draw them all. They are highly motivated—both by the demands and variety of the unit and by the quality of what they produce. They are proud of the professional appearance of their reports and consider it a bonus to be able to paste in the graphical work completed earlier as evidence to support their arguments. In all these ways, the use of ICT frees up time to discuss the real science and its applications in the real world.

The skills which the pupils develop will serve them well in other science activities.
Swing time - capturing the moment with a palmtop

Palmtop PCs are a good idea for teaching and learning science! They are versatile and simple to use. They add a flexible extra dimension to science teaching - especially when students need to analyse voluminous data or detect and measure rapidly occurring changes.

Data-logging happens to be a good way of teaching difficult bits of science if applied judiciously. In turn, science can play a unique and practical part in teaching the use of ICT for measurement.

Data-logging at its most flexible needs:
- a computer.
- an interface.
- sensors to detect and measure changes such as temperature, light etc.

This article will look at an example of how palmtops and data-loggers can teach kids science more effectively! First, however, it will summarise some advantages of palmtops over desktop PCs.

The problem
My department was using six desktop PCs on trolleys and six fixed desktops in a lab. Clearly another solution was needed. Plugging everything together, booting up and working through menu systems in Windows could take up most of the lesson. Then everything had to be packed away! Only limited numbers of students could participate actively.

The solution
Palmtops are small, portable and relatively inexpensive. We purchased a set of 12 Psion series 3 palmtops three years ago to complement the sets of Dataharvest ‘Sense & Control’ interfaces and sensors we had built up over a number of years. They cost the same as a couple of desktop PCs.

The palmtops have ‘always-on’ software with simple intuitive menus and only two wires to plug in. They are quick to set up and much less stressful for staff and students alike. (A regular INSET programme supports their use.)

An example
Our Year 7 students use palmtops and an angular position sensor to measure the period\(^1\) of a swinging pendulum.

Without ICT, an organised team using a pendulum and stop clock would need great patience, accurate measurement skills, some maths, and a complex table to investigate even one factor successfully. Using the palmtops, the students can investigate the effects of a range of factors such as changing the bob size or string length.

They simply set up a conventional pendulum but tie the end to an angular position sensor held in a clamp-stand. The sensor plugs into an interface, the interface plugs into the palmtop. That’s it! A couple of menu clicks and they can start logging.

\(^1\)This is the swing time - duration of one complete swing.

The whole class can be actively involved in measuring and analysing data in groups of two or three. No matter how inventive I was, I could never achieve this safely in a lab with desktop machines!
Simple graphing software lets them 'see' the different periods of their pendulums as they happen: an abstract concept made clear in a concrete graph. Applying simple 'analyse' functions to the graphs allows accurate measurement of the time between swings.

The students are amazed that the swing time is always the same for a given string length, irrespective of the swing size. They are also surprised that the swing gets faster with shorter strings but is unaffected by the mass of the bob. All this is hard to measure conventionally - one swing is just too fast. Conventional measurement also requires accuracy and the ability to calculate mean values - demanding for the less able!

Further advantages
Palmtops have basic word-processing, spreadsheets and databases, so can be used to take the pressure off hard-pressed computer suites. Data or other files can be converted into Windows or MAC format and downloaded through cables plugged into networked desktops to develop work done in the lab.

The future
Psion or Acorn palmtops have been popular in schools, and will continue to give years of use to schools that have already made this investment. They feature on the cover of the new QCA Science scheme of work!

But palmtops are becoming even easier to use. The latest versions have no keyboard. They recognise handwriting and a pen is used to operate their colour screen. They link simply to PCs and transfer files with great ease to Windows programmes. They can access the Internet and school networks.

It will be a few months before data-logging software is available for this new generation of machines but they promise an even more powerful and flexible way to teach science more effectively!

The technology lets students of all abilities access these elusive ideas and gives scope for the more able to investigate more factors more fully in a short time.
Stuck outside the ICT suite? Try these ideas

With vast amounts of money being spent on computer suites, teachers might be expected to use these facilities whenever computers are needed to deliver all or part of a lesson.

However, there are sound alternatives to the computer suite. Let’s consider some examples:

1. The teacher can use a single computer for demonstration purposes. There is a limit to how many pupils can see the screen - probably no more than a dozen at a time. Even then it may not be possible for them to read numbers from the screen. The teacher will inevitably turn his or her back on the class to operate the keyboard and look at the screen. I find it helps to get one of the pupils (a ‘trusty’) to operate the machine and relay the data to the class, leaving me free to engage in the discussion.

2. Sometimes an exercise can be carried out by a small group, working together at the computer at once. Two or more pupils, working cooperatively, often get more out of an exercise than when working singly. They need a worksheet with instructions, questions to answer and a space to record what they find out. In a 45 minute lesson, about five groups can spend five minutes each at the computer (allowing time to introduce the lesson and time for each group to settle at the screen). In the meantime, the rest of the class needs to be engaged in other constructive, independent work for up to 35 minutes. Alternatively, the teacher can try to lead a lesson whilst groups go up to the screen and carry out their exercise.
3. Physics teachers often create a circus of activities, one of which can involve the computer. Again, an explanatory worksheet needs to say what to do, introduce the topic and give space for pupil response. The activity needs to stand alone and be set up in a way that lets the pupil work unassisted.

4. A computer exercise can be conducted outside a lesson - for example, during lunch time. This can work very effectively with a well designed worksheet and with supportive computer staff who are aware of the nature of the exercise and can ensure that the software or facility is available at the right time.

5. Sometimes pupils may benefit from using a computer on their own to test, stretch or teach themselves or to catch up. The computer might be in a library or resource centre.

6. Computer-based homework exercises often work well, especially with older pupils who might be given a week or so to complete the task. Sometimes, sets of pupils can be given different exercises and the next lesson can be a discussion in which the teacher is not supplying information but drawing on the different resources that each pupil has to offer. It is important to ensure that pupils who lack the necessary facilities at home can gain access to school equipment for this purpose.

   If pupils get sidetracked to unanticipated sites while using the Internet outside a lesson, then they are free to wander (this can be good). Valuable lesson time is not being lost, yet interesting avenues can be pursued.

   With any of these approaches, careful planning is needed to minimize problems and help pupils work effectively.

   The technology must always take a back seat. It should facilitate learning not overwhelm it.
Good practice in the use of ICT in Mathematics, Science and Geography at Key Stage 3

Safe routes and citizenship - putting your school on the map

Gwil Williams, Head of Humanities, and Julia Harper, Deputy Head of Sixth Form, Horndean Community School, Hampshire

Horndean Community School has almost 2,000 pupils aged 11-18, making it the largest secondary school in Hampshire. It is located ten miles north of Portsmouth and caters for pupils from commuter villages in the nearby locality.

Historically, with such a large number of pupils and only one main entrance, movement at the start and end of the school day led to severe congestion. A transport plan was essential and this led to our involvement with SUSTRANS, a charitable organisation promoting cycling and a programme called ‘Safe Routes to School’. An initial survey of our pupils showed that almost three times as many relied on cars to get to and from school, compared with the national average. Only 14% of our pupils travelled by bus compared to a national average of 34%.

The first step was to set up a working party involving pupils, staff, local councillors, planners and traffic police. Our local Safe Routes to School co-ordinator chaired this group. We then set about designing a scheme of work exploring pupils’ methods of travel to and from school, reasons for the methods chosen, perceived danger points along pupils’ routes and possible solutions to the school’s traffic problems. We used a software package which enabled us to manipulate digital map data from the Ordnance Survey into a computer-generated image.

Originally we used Minerva’s ‘Map Importer’ programme on our Acorn Archimedes computers. More recently we have progressed to MapIT’s ‘Map-Maker Pro’, using a PC format. This programme lets pupils:
• Zoom in and out of a local map with ease, reflecting a range of scales.
• Annotate and label features on the map.
• Show danger spots and use a range of symbols to suggest solutions, e.g. cycle routes, road bumps, traffic lights, pinch points, rumble strips.
• Plot their route to school (there is even a directory to assist pupils in finding their street).
• Measure distances accurately.
• Spend more time involved in decision-making exercises rather than copying/tracing maps.
• Produce a professional looking map (a helpful feature especially for students with special needs).

Some of the above applications are shown on the next page.

As geographers, we felt this gave us an ideal opportunity to develop a scheme of work on sustainable transport.

In addition we have used other ICT techniques within the module. We became involved with a Comenius project via the European Union, which linked us with schools in Belgium and Austria. Pupils were able to exchange information on transport issues in their countries, through email and video conferencing.

The amended Key Stage 3 National Curriculum Programme of Study in Geography places key emphases on development of the enquiry process and the application of ICT. Through our teaching of the sustainable transport (SUSTRANS) module, both these areas are covered. For example:
• Pupils use maps and plans at a variety of scales, including Ordnance Survey digital maps.
• Pupils select and use secondary sources of evidence, such as information from the Internet e.g. the SUSTRANS website (sustrans.org.uk)
• Pupils communicate and exchange ideas in a variety of ways e.g. emailing students in partner schools.
• Pupils become involved in decision-making exercises e.g. locating a cycle route in the local area.
• Pupils develop their ideas, using ICT tools to amend and refine their work and enhance its quality and accuracy.

Since the introduction of the SUSTRANS module and the use of digital map data, our pupils have become much more involved with Safe Routes to School. Their increased motivation and the dynamic approach made possible by digital map data have clearly increased their awareness of our local transport problems and the possible solutions.
In addition, a recent survey on journey to school patterns revealed that the number of pupils coming to and from school in cars had dropped by 18% since 1996, whilst the number of bus users and walkers had increased significantly.

It has now become relatively easy for schools to become involved with digital map data and Safe Routes to School. Commercial software products are available for schools and these are summarised in the summer 2000 edition of Mapping News (the Ordnance Survey magazine for schools). To find information on the Safe Routes to School project, you can contact Sustrans or visit their website. Also you will find the DfEE’s ‘A Safer Journey to School’ and DETR’s ‘School Travel - Strategies and Plans’ invaluable.

Further Information:
Sustrans 35 King Street, Bristol BS1 4DZ www.sustrans.org.uk
Safe Routes to School Helpline Tel: 0117 915 0100
General Information Line Tel: 0117 929 0888

A Safer Journey to School (Transport 2000 1999) available free from DfEE Publications, PO Box 5050, Annesley, Nottingham NG15 0DJ
Tel: 0845 602 2260 • Fax: 0845 603 3360

School Travel - Strategies and Plans (DETR 1999) a best practice guide for local authorities and schools, available free from DETR free literature, PO Box 236, Wetherby LS23 7NB
Tel: 0870 122 6236 • Fax: 0870 122 6237

Digital Map Data Contact Information, Ordnance Survey, Romsey Road, Southampton SO16 4GU Tel: 02380 305534 www.ordnancesurvey.gov.uk or see the latest copy of ‘Mapping News’

Map Maker Pro - Student Edition produced by MapIT incorporates a simple drop-down menu that allows students to add a variety of features such as rumble strips, pinch points etc. to their maps. They can also map their journeys to and from school, measure distances etc.
Contact Doug Cross Tel: 01487 813745 www.mapituk.co.uk

The working party we established at the outset put forward proposals for a large-scale traffic calming scheme. These were implemented in 1999.

Horndean Community School

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Reproduced from the Ordnance Survey map by kind permission of Her Majesty’s Stationery Office. ©Crown Copyright NC/01/024.

Software supplied by MapIT LTD.
ICT can reduce rote work, allowing more effective use of lesson time to enhance pupil learning. This is especially true of tasks involving many repetitive calculations; in such cases, spreadsheets can provide a very useful alternative to pen and paper.

The study of variation in humans, often covered in Year 9, provides a good example. The aim here is to demonstrate the difference between continuous and discontinuous variation, and to show the distribution of various features throughout the population.

The traditional method typically involves the pupils gathering data about themselves or a partner (height, head circumference etc) and then tallying these results manually on the blackboard. The pupils then manually plot graphs of the data. This is a time-consuming and laborious process which tends to direct their attention away from the science, especially in lower achieving groups.

Instead, the teacher can prepare a spreadsheet template, similar to the one below, which can be used by pupils to enter data.

This spreadsheet is set up so that automatic tallies of measurements are displayed in table form, cutting out the need for excessive ‘number crunching’ on the part of the pupil. (Formulas are provided at the end of this article.) The charting function available in many spreadsheet packages can be used to set up graphs on subsequent pages of the spreadsheet. These will ‘draw themselves’ as data are entered, again saving valuable lesson time. The lesson can then be used more fruitfully, to discuss the meaning of the data and the underlying science. The teacher can also raise questions such as what sort of graph is appropriate for various situations, and pupils have the facility to investigate different types of graph for themselves.

Pupils’ interest is readily retained as they see instant, tangible results from their efforts, rather than being distracted by other tasks before getting to the point.
Extending the Science

In addition to making life easier, the use of spreadsheets in this case allows pupils to explore their data more fully, and encourages inquisitive thinking. They could be asked questions such as, “Do tall people have big feet?” or “Do people with big heads have long fingers?” By plotting scattergrams of two sets of values against one another, again using the charting facility, pupils are encouraged to think about what the shape of a particular graph shows. Is it just a random collection of points, or is there a pattern? Is a line of best fit appropriate in this case, and if so, what does the slope/direction of the line tell us? All these questions are easy to investigate using the spreadsheet, while it would obviously not be possible to produce so many graphs using pen and paper.

Combining several sets of data from other classes or previous sessions can be used to demonstrate how sample size affects accuracy. If for instance, height data from a single group are plotted, then two groups, then four, then six, the resulting graphs will become closer and closer to a standard distribution. These activities will encourage children to think in an inquisitive way which will aid their performance in future investigations, especially in SC1 practical assessments.

In essence, the use of a spreadsheet and a little preparation on the part of the teacher can greatly enhance and extend a tried and tested investigation.

Useful spreadsheet formulae:

Example: to count number of entries less than 1.45 in a range A2 to A10 use
=COUNTIF(A2:A10,”<1.45”) To display entries in range 1.45 to 1.50 use
=COUNTIF(A2:A10,”<1.45”)+99 where 99 is the cell containing the answer to first calculation. To count cells with the entry ‘blonde’ in a range E3 to E57, use
=COUNTIF(E3:E57,”blonde”)

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Squared away at Fort Nelson - a mathematical field trip

All schools are familiar with field trips organised by History, Geography and Science departments. Visits to Europe are regularly undertaken by Modern Languages, while Art, Drama and English departments see visits to the theatre or galleries as a necessary part of their courses. However, very few Mathematics departments ever consider the possibility of taking pupils on a Maths visit. This is sad, as museums and other places of interest provide a rich resource that enables children to begin to make sense of many of the mathematical concepts they encounter in school. Field trips can also be used as an introduction for learning new skills.

At Cams Hill School, a Maths trip is organised for Year 7 pupils towards the end of their first half term at the school. The visit is to Fort Nelson, which has the advantage of being only half a mile from school. Fort Nelson is a Victorian fort built to protect Portsmouth from the French. By the time it was completed the country was no longer at war and so the Fort, together with the others built nearby, became known as one of ‘Palmerston’s Follies’ after the Prime Minister at the time.

The visit to the Fort has been developed over a number of years. The project has three main objectives.

• To raise awareness of Mathematics as being all around and not just in the classroom.
• To introduce pupils to a variety of mathematical experiences.
• To emphasise the fact that Mathematics plays an important part in many other subject areas.

In addition, many ICT skills are introduced.

A number of differentiated activities have been written covering a range of mathematical topics, including algebra, statistics, co-ordinates, ratio, scale drawing, angles and bearings and graph work. They link with Geography, Science, Technology and, of course, History.

The activities are also designed to introduce pupils to the wide range of ICT applications available to them.

The tasks are based on the design of the building, its position, its purpose, the artefacts it contains [for example, cannonballs stacked in pyramids] and the history of the Fort. In producing the work, I had to exercise some discretion to prevent the whole project from becoming unwieldy. I could easily have had double the number of activities. A revealing remark was made by one Year 7 pupil, ‘My Mum went to Fort Nelson...she said there was no maths there!’ If only she had come with us, as parents are always invited to do.

Prior to the visit, a group of pupils from each class is shown how to use digital cameras. They then cascade this information to the rest of the class. By the end of the visit, a file of digital photographs will have been created to which all pupils have access. During the visit, a number of mathematically based activities will be tackled. These have been developed by the Education Officer at Fort Nelson with reference to our needs.
Two weeks of lessons are set aside for the project. Each child is expected to complete just two of the activities. It is left to the discretion of the class teacher whether the children have a free choice (with guidance) or whether one task will be a whole-class activity and one a free choice. The class teacher will also decide if the pupils will work in groups or on their own. All the activities have been installed on the school’s computer network as well as being printed. The children work in the ICT suite as far as possible. For the most part, ICT is used simply to enhance the mathematics but at least one activity would not be possible without a graph plotter or graphical calculator.

All the pupils are encouraged to share their work by producing it for display. They also give a presentation to their class, which could involve the use of PowerPoint. Some classes produce a news sheet on Publisher incorporating everyone’s work. These displays are used at parents’ evening, hopefully extending some parents’ perception of mathematics.

Although no one child will have experienced every task or every ICT application, the ensuing displays whet their appetites and encourage discussion and new skills are shared. “How did you do that?” and “Can you show me?” are comments that are often heard.

Many of the activities will be revisited later when they are relevant to the topic being taught. The databases, which have been built up with the help of the Fort’s education officer, are invaluable in providing interesting data for much statistical work. Work on quadratics in Key Stage 4 may well refer back to the idea of trajectories introduced in the course of this project.

A visit like this gives the children a valuable experience, raising their awareness of mathematics, encouraging them to focus on the need for mathematics in the wider world and enabling them to see that maths is an important part of many other subjects.

I certainly recommend you to try one.
Good practice in the use of ICT in Mathematics, Science and Geography at Key Stage 3

Postscript

Teachers who attended the March 2000 Conference on Good Practice in the Use of ICT had the opportunity to engage in a dialogue with Dennis Stevenson (The Lord Stevenson of Coddenham, CBE), the Prime Minister’s Adviser on the Application of ICT to Education and Chairman of Pearson plc. Excerpts from the dialogue follow.

Prior to the last General Election, Dennis chaired an independent inquiry on Information and Communications Technology in UK Schools. The report of that inquiry, published in March 1997, made a strong case for intensifying the use of ICT in schools and recommended many of the policies since implemented by the Government.

The greater part of our report has been implemented. A huge resource has gone into schools. We are three years in, so it’s a good time to be taking stock and asking what we’ve done right, what we’ve done wrong. I am open to all suggestions, questions, rotten apples from anybody present, and to being educated and informed by the debate today.

I cannot resist the temptation to put on the table one or two of my own prejudices. First is the obvious one. I believe passionately in the selective application of ICT to improve learning. Although conclusive evidence of its importance will not be available for some time, it would be remarkable if school education proved to be the one area where effectiveness and productivity were not dramatically increased by the application of ICT.

The second item on my agenda is the digital divide. We warned about this very heavily in our report to Tony Blair before the election. It is a huge issue facing us.

Third is the issue of teacher training. We are at the early stages of an historic investment in teacher training. It would be astonishing if there were no lessons to be learned from that experience and no adaptations to be made. Increasing numbers of teachers are competent and confident in the application of ICT to their subjects. The issue of how we transfer their wisdom and knowledge, fruits of their hard-won experience, across to all teachers is high on my list. This is the subject of our debate today.

My final issue is investment in broadband - how we should think about broadband and the practicalities of its introduction. I don’t expect there are any easy answers to this.
Q: Through the 80s and early 90s, subject associations were involved in developing topic-specific educational software. Government could help by providing finance for updating this software, which people still think is important or valuable but which needs to be put in an up-to-date Windows® environment.

Any precise prescriptions regarding products that are relevant and effective, that could be readily translated, would be gratefully received.

It is certainly the case that there is a lack of relevant software for many purposes in this country, although the problem is diminishing. How government should intervene is a question requiring the wisdom of Solomon. I've heard the battle tales. There is a long track record of previous governments wasting a lot of money and incentivising the private sector to lose money. There is a sense among government officials that we mustn’t do that again. There is also a scepticism about picking winners.

Q: Typically, there are public funds available to pilot an educational website but not to keep it going. Innovation is politically sexy. Maintenance isn’t. I run a valuable educational website and would like to sustain it without accepting advertising or turning it into a commercial product but I am hard-pressed. Ongoing support for free educational websites would be cost-effective and a good way forward.

It is unbelievably difficult for Ministers or civil servants to make choices of that kind with scarce resources. Everyone has got an MP to run to, to ask Parliamentary questions and make a fuss if things don’t go as they would like. I can think of several websites that are fulfilling an incredibly useful role but struggling to survive. I worry about their continued existence but it is difficult to imagine how Government would choose among them. While I can understand a disinclination to take advertising, I do wonder whether sponsorship may not be the right way forward.

Q: There is great concern that teachers are being expected to get ICT training on their own time, with very little accreditation at the end. This is quite a big issue with many teachers, particularly those who don’t yet use ICT. It is difficult to persuade them to take the offer up under the circumstances.

I have no balm for you because I understand that concern and to some extent share it myself. The fact that we recognise the need for an investment in teacher training is a massive improvement in itself. From the point of view of the teaching profession, these skills are ‘must have’ skills. To some extent the system is saying, ‘Here are the terms and conditions.’ I don’t want to be negative, but that’s how it is.

Q: With so many new initiatives emphasising ICT, the job of the ICT co-ordinator is becoming increasingly important. ICT co-ordinators need support and training in how they go about knitting together ICT provision across the school. It’s a very demanding job for me to ensure progression and continuity in ICT across all subjects, and ICT for all. I can’t see where I’m getting support in how to do that.

Point noted. If you have prescriptive ideas as to what can be done with reasonable resources to help support ICT co-ordinators, please let me have them.

Q: We welcome the move to provide teachers with computers and to pay towards that. However, we’d like to ask you to look into this business of some of it being taxed.

I have strong views about teachers’ computers being taxed. It’s a difficult one. I have the greatest of sympathy with the Inland Revenue but clearly we ought to be moving to a situation where, if a teacher puts his or her hands into his or her pocket to buy a computer which is to be used substantially for work purposes, there ought to be some means of getting a tax break on the cost. The Government is looking at this and doing its best. The Treasury has explained to me the problems of precedent etc. it would set. All I would say to you is that I don’t need any persuading of the arguments and it is only a matter of time before dams are breached. In fact, some dams are being breached.

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Q. Collaboration with other professionals is an essential component of continuing professional development and therefore should be supported and funded by schools as an entitlement for staff. Secondly, there should be an imperative to pay teachers for materials they develop and share. We don’t have an analogy anywhere that I can think of, within industry or a profession, where your own work, your intellectual property, is taken from you and simply reused without appropriate reimbursement.

Those sound like wise words to me. There is clearly an issue about recognition and reward, and a perfectly legitimate one. So many people like you are embarrassed almost to raise it but it is perfectly plain within a democracy that if you’re going to get anywhere, there will have to be organised pressure. It is not enough for nice people to say, ‘Hey, this should happen.’ You are going to have to press.

Q. What are we doing to review our infrastructure investments to ensure that they’re having the intended effect? It’s terribly important that we learn from what we’ve done already before we go into the next round of spending. It is a mystery to me how the DfEE makes decisions about allocations of money to LEAs under these programmes. I have been incredibly impressed by the conscientiousness and effectiveness of officials in the DfEE. They have a difficult, almost impossible job. Similar questions confront industry. We’re all trying desperately to do our best. ‘Are we right to make a major investment in laptops? What about interactive television? How will that alter things?’ There are emerging technologies coming from every direction. In the DfEE and indeed BECTa, we’ve got as good as we can get in terms of human beings standing back and making hard judgments.

This gets back to the heart of our discussion. We are all part of a dramatic revolution caused by changes in technology and a smaller world. I think you – the teachers – have the considerable challenge and difficulty that you are working in a less fluid, more constrained system than people in the so-called private sector, which means there are more frustrations and more difficulties in getting your way and representing your point of view. But that is the reality. It is not easy.