

2. Teaching using ICT

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Introduction

This chapter investigates the implications of using new technologies for classroom practice. It examines the level of technical skills and capability that is required to start to use new technologies in the classroom and the management and pedagogic issues involved in their effective deployment for learning. It also considers the impact of new technologies on what is to be taught and learnt, on what constitutes education, and of their effect on the role of the teacher in the classroom.

In order to help understand the importance of these issues for classroom practice, it may be useful to compare recent developments with change in communication technology that took place long ago: the introduction of books and writing to schools. Imagine that you were teaching in a school without books, where no-one (including you) could read or write. Then the government of the day decided that every school should have books, that every pupil should be taught to read and write and that this new literacy should be used to aid pupils' learning across the curriculum.

As a teacher you would face many challenges, including those involved in:

- improving your own level of 'book-related' skills, such as reading and writing;
- learning when and where to use these skills;
- teaching these skills to your pupils;
- helping your pupils use these skills to facilitate learning in all curriculum subjects;
- organising your classroom to make most effective use of the new kinds of resources; and
- rethinking what being an 'educated person' means.

The introduction of new technologies into schools today is a revolution on a similar scale, and poses precisely the same kinds of challenges to teachers – with two important differences:

- unlike the introduction of books, the change is not taking place over decades or centuries, but in months and years;

- the nature of books, and what (in principle) you can do with them, has not changed significantly since they were first printed hundreds of years ago. By contrast, the nature of the new technologies is evolving rapidly. For example, in the mid-1990s hardly any school had internet access but by the end of 2002 most London schools will have fast, broadband internet connections. Three years ago almost no-one had heard of SMS but today most school children are highly proficient in sending text messages to each other via their mobiles.

The speed and continuity of change pose great challenges for teachers. However, it is important to be clear about what is *not* changing as well as about what is. New technologies do not require teachers to change the basic **principles** of good pedagogy, such as a focus on pupil learning and collaboration but, by offering exciting and powerful new kinds opportunities to implement these principles, they do require changes to classroom **practice** in order to enable full use of the opportunities now available. These changes do not simply (or even primarily) involve ‘grafting-on’ the use of new technologies to existing practice but, by changing the nature of what there is to be taught, involve the teaching of completely new capabilities (see also Noss and Pachler 1999). They also – as did the introduction of books – not only, or even primarily, allow teachers to teach the same things better but transform what they teach and why. The real challenge to teachers is not to rethink basic principles of what constitutes ‘good teaching’ but to develop three capabilities:

1. a vision of why these new technologies are of use, of how they can improve and transform pupils’ learning, and the teacher’s role in this process;
2. the technical skills and capability to allow teachers to begin to use them with confidence; and
3. the organisational skills required to use these technologies effectively for defined purposes.

The remainder of the chapter discusses each of these three capabilities in turn.

Objectives

By the end of this chapter you should:

- understand the opportunities that new technologies give for different modes of teaching;
- be able to evaluate your own ICT literacy and pedagogic knowledge;
- understand that ICT skills and knowledge about teaching can be developed through using ICT in teaching;
- understand the principles underlying the design, use and evaluation of classroom materials that use new technologies; and
- understand the management and organisational issues involved in using new technologies in teaching.

Pedagogic skills

New technologies offer teachers new opportunities to help their pupils learn. As they also fundamentally change the nature of what there is to be learnt they pose the challenge of developing new pedagogies which exploit their potential to the full. In this section I introduce some of the changes in pedagogy required by looking at four questions:

1. How do new technologies change what is important for pupils to learn?
2. What are the purposes of pupils 'working on the computer'?
3. How can you evaluate the suitability of CD-ROMs and web-based material for use in your classroom?
4. What effect does using new technologies have on the role of the teacher?

How do the new technologies change what it is important for pupils to learn?

Three important ways in which new technologies change what is important for pupils to learn are:

1. they emphasise the finding, understanding and interpreting of information rather than its memorization;
2. they allow pupils, in a wide variety of ways, to communicate their own ideas and their interpretation of the ideas of others to an increased diversity of audiences; and

3. they let pupils create 'worlds' which work according to rules they determine and thus test out their own ideas, rather than simply trying to understand worlds described by their teacher.

Finding, understanding and interpreting information

In *Hard Times* Charles Dickens famously described Mr. Grandgrind's view of education.

Now what I want is Facts. Teach these boys and girls nothing but Facts.

Facts alone are wanted in life. [...]

The speaker, and the school master, and the third person present, all backed a little and swept with their eyes the inclined plane of little vessels then and there arranged in order, ready to have imperial gallons of facts poured into them until they were full to the brim.

Mr. Gradgrind would not have approved of classrooms that utilise the promise of new technologies, since their overwhelming feature is the reduced importance of facts. This has a number of important results:

- a it changes the role of the teacher. The teacher can no longer be seen – either by herself or her pupils – as the sole source of information;
- b because so much information is available and because there is no form of quality control, teaching pupils how to find relevant and viable information efficiently is essential;
- c since it is easy to find information on just about anything, remembering specific information becomes far less important. As teachers we can (and have to) become much more selective in what we expect our pupils to remember.

Communicating their own ideas and their interpretation of those of others to a wide variety of audiences

Perhaps the most exciting feature of new technologies is the scope they allow for new forms of communication.

When my mother emigrated to England 50 years ago the only way that she could contact my father in Ireland was by letter. With careful planning by letter they could occasionally talk to each other by booking a call to the village where my father lived, that is to say, to the one phone in the place, which was owned by the doctor. Today, matters could hardly be more different. My partner lives in Greece but, using cheap

web-cameras connected to our PCs, we can talk to and see each other at any time of day or night – for the price of a local phone call.

Innovative new forms of communication are not limited to those associated with the internet and e-mail. Desk-top Publishing software has made it much easier (and cheaper) for individuals and organisations to produce books, leaflets and posters to publicise themselves and their ideas. There is also the use of SMS by pupils. Increasingly pupils have to address questions such as:

- What is the most appropriate way of communicating to the audience I wish to reach?
- What principles should govern the design of the materials which I use to communicate my ideas to the audience I wish to reach?

Creating ‘worlds’ which work according to rules which pupils determine so that they can test out their own ideas

Modelling tools that allow pupils to create worlds which work according to rules they determine are becoming increasingly available to schools. A good example is the ‘WorldMaker’ programme (see <http://worldmaker.cite.hku.hk/worldmaker/pages/>), initially developed at the Institute of Education, University of London, but enhanced greatly by educational researchers in Hong Kong. Programmes such as these are most obviously useful in science lessons where pupils can, for example, create gravity-free worlds to explore their understanding of physical phenomena. For the first time, pupils can see the result of a world which functions according to their own conceptions and ideas. This gives teachers a powerful tool with which to help change pupils’ misconceptions. However, ‘world-creating’ programmes have uses in many other curriculum areas too. A good example is the ‘Sim-City’ suite (see <http://simcity.ea.com/us/guide/>), which – by allowing pupils to create cities and countries and explore the effects of changing economic and demographic factors – are of use in helping pupils explore geographic and sociological concepts.

In all these examples the emphasis is on the development of understanding and skills.

Activity 2.1

- Find two CD-ROM or internet-based sources of information that would be useful in your teaching.
- Identify two new audiences or ways of communicating made possible by new technologies.
- Where appropriate, identify a modelling tool or system that can help your pupils express their own understanding of important concepts.

What are the purposes of pupils 'working on the computer'?

'Working on the computer' is not an undifferentiated activity. It can have many different purposes and it is crucial that the activity matches the desired learning outcomes. For example, when using database software, pupils can be spending time:

- thinking, e.g. deciding where a field should be created and what it should be;
- investigating, e.g. looking for patterns in data;
- copy typing, e.g. where they copy data into an existing database;
- following instructions, e.g. they are given a printed list of instructions telling them how to create a database.

Clearly the first two are more valuable than the second two but unless careful thought has been given to the purpose of each activity, i.e. to the learning that the teacher intends to bring about, it is easy to plan lessons where the pupils spend much time doing less valuable things.

For example, one of my trainee teachers spent a lesson showing pupils how to refine a search for satellite images of the earth for use in a geography project. He carefully took them through each step in constructing a complex search by doing each step himself on the computer attached to the display monitor and then having the pupils repeat it. At the end of the lesson he claimed that they could now do searches. However, there was no evidence of this since all that the pupils had done was follow the trainee teacher's instructions. Had he spent the final few minutes of the lesson allowing the pupils to use the strategies he had taught them to find another site – rather than copying the contents of the site found into a 'Word' document – he would have known how many pupils had understood the procedure and were able to use it.

A useful technique for avoiding this problem is to map activity time against the intended learning outcomes for the lesson. This will help to identify those periods of time when the pupils are doing things that do not relate directly to learning outcomes.

Activity 2.2

Draw up a list of various purposes of computer-based activities used in your teaching. Add to the list throughout the year.

At the end of each term, examine the range of purposes covered and the number of times you have focussed on each.

Evaluating CD-ROM and internet-based teaching resources

When evaluating CD-ROM and internet-based materials for your lessons, the key point is to use the same principles that you would use to evaluate any other educational resource as well as to ask yourself what the resource offers compared with more traditional resources. However, with professionally produced materials it is easy to suspend one's critical faculties and allow style to triumph over substance. (See also chapters by Pachler and Ortner.)

For example, a colleague of mine who is a passionate advocate of 'active learning' at first thought that a CD-ROM, designed to help pupils learn about electricity, was very useful. The CD-ROM consisted of pages of text, each accompanied by a moving image. However, the only pupil activity involved was to read the text on one page then click on an icon to move to the next page, where this whole process was repeated. Had this been a book-based resource, my colleague would probably not have given it a second glance, and she suspected that she had briefly been unduly impressed by the animations accompanying each page of text.

Almost all CD-ROMs stress that they are interactive. For a detailed discussion of the notion of 'interactivity' see Heath 1995. When evaluating CD-ROMs you need to think carefully about the nature of this interaction – is it 'mind-on' or just 'hands-on'? That is to say, does the software require pupils to think and make judgments before clicking on something?

A good example of the use of CD-ROMs is 'The Chemistry Set' (see http://195.200.1.65/new-media/products_cs2k.asp). Amongst other things this CD-ROM contains a picture of the Periodic table in which the colour of the box for each element depends on whether it is a solid, liquid or gas. The system lets the user set a temperature. As this is varied, the colour of the boxes for each element changes as its

state does. This allows the periodic variation in boiling and melting points to be seen in a way that neither book- nor paper-based activities would allow.

Activity 2.3

Use the criteria in Table 2.1 or those available at <http://www.becta.org.uk/schools/websiteawards/criteria.html> to evaluate the CD-ROM and internet sites you found in Activity 2.1 above. Does this change your view of their suitability?

Table 2.1 Evaluating CD-ROMs and internet sites

First impressions

- Does the resource look attractive and inviting to use?
- Do text and pictures complement each other or confuse?
- What is the advantage of using this CD-ROM/internet site over printed material or would the resource work better as printed material (e.g. as a short book rather than a long webpage of text)?

Using the resource

- How easy is it to find the information you want (e.g. through an index or search facility)?
- How easy is it to move around? (e.g. Are the links easy to find and consistent in use?)
- How easy is it to get lost? (e.g. Is there a simple way of getting back to a place you have already been?)
- What is the nature and extent of the interaction with the user? (e.g. Does the user just read or can she explore ideas?)
- Can you access the site without long delays or does it take a long time to download to your machine?

Content

- Is the information correct?
- What underlying values does the resource promote?
- When was it last changed/updated?
- Are the content, reading age and presentation style all consistently appropriate for the intended users?

Classroom use

- Does the resource promote enquiry?
- Does the resource lead to differentiated tasks and/or outcomes?
- What learning do you expect to take place when your pupils use this resource?
- Where does that learning come from? (e.g. Is the resource 'the teacher' or are the pupils learning by exploring, investigating and testing their own ideas?)

- How could you structure the use of this resource in the classroom to enhance pupil learning?
- What would you and your pupils need to know in order to use this resource effectively?

What effect does using new technologies have on the role of the teacher?

It is central to the role of a teacher to help pupils learn. As the nature of what is to be learnt changes, so does the role of the teacher in that process. The teacher was once the sole source of information. She was expected to know all the relevant knowledge and to transmit it effectively to the pupils.

However, it has already been noted that pupils now have access to more information than any teacher can ever know. This – in my view – necessitates a welcome change from the teacher being regarded as the source of all knowledge – an instructor – to the teacher as someone who shapes the learning experiences of her pupils and helps them develop the skills and understanding to find, evaluate, interpret and communicate knowledge – a facilitator.

In addition, there is the need to recognise that teachers are not the only source of knowledge in a classroom. Indeed, in some areas they may not even be the main human source. In many classrooms, some of the pupils will have far better technical knowledge of many of the software packages used than their teachers. This is certainly true of my classroom. I train specialist Information Technology teachers; many of my trainees have a far better technical proficiency in programming languages and database software than I have – or will ever have.

For many teachers this is an uncomfortable change. They had a role in the traditional classroom that they understood and which gave them a clear status within that classroom. If they do not have the knowledge, indeed, if some of their pupils are more skilled than they are in some areas, are they not being de-skilled by the new technologies?

The answer has to be no. The role of the teacher is not being diminished but changed. What is necessary above all is that teachers develop the confidence that they are important to their pupils, not because they happen to know some facts that pupils do not know, but that they have a vision of what they want pupils to be educated in as well as the requisite knowledge, skills and understanding to facilitate and monitor pupils' progress. The fact that pupils may know more about the operation of a

particular piece of software than the teacher can be of benefit to both. For example, when I taught chemistry in schools one of my pupils used to earn more than I did by writing computer games! So I set him the task of writing a programme to display the rates of reactions from the data fed into a computer by a colorimeter. He did it and learnt something about both computing and chemistry in the process.

If, as a teacher, one is unsure of one's new role, then using new technologies can actually decrease teacher effectiveness. For example, teachers who are not confident in the classroom tend not to ask pupils questions or allow pupils to ask them questions because they fear that they might not know the answers. As a result they tend to plan very 'closed' lessons which do not allow the pupils to explore or investigate as much as they might.

Two trainee teachers whom I saw team-teach a lesson may be used here to illustrate the difference between the 'instructing' and 'facilitating' roles. One put a list of instructions on the board which the pupils were to follow in order to construct a 'PowerPoint' presentation. The pupils then tried to follow these instructions and the two teachers moved around the class helping them – but in very different ways. Every time a pupil asked the teacher who had introduced the lesson for help he simply referred them to the list of instructions or took over their machine and tried to sort out their problem himself, without explaining to the pupil what he was doing. The other trainee, a geography specialist, took a different approach. When the pupils asked her for help, she started by asking them to explain what they were trying to do and why they had hit the keys they did in order to do this. In the course of explaining to her almost all pupils realised where they had gone wrong and corrected their mistake. She could help the others with an explanation of their mistake as well as telling them how to correct it. Unlike the first teacher, she was doing little overt 'telling' but the pupils she helped did far more learning.

When computers were first thought of as educational tools, many articles and letters appeared in the press promoting (or being fearful of) the idea of 'teacherless classrooms'. New technologies do allow for this but not at all in the way that these articles imagined. The articles had conceived of lessons as being predominantly about the giving of information to pupils, albeit by machine rather than human beings. The

new promise, illustrated by the example above, is to replace human instructors with human guides.

Activity 2.4

Ask a colleague to use the two observation schedules in Tables 2.2 and 2.3 to focus on you and the pupils while observing one of your lessons. As a result of the observation, choose one area listed on the schedules that you want to develop and repeat the exercise some time later to monitor your progress.

Table 2.2 Observation of a computer-based activity: teacher focus schedule

Focus	Observation
<p>Purpose of activity What is the purpose of the activity (e.g. to develop knowledge, skills or understanding)? How is this made clear to the pupils? Is the content an appropriate use of ICT?</p>	
<p>Content of the activity How are the pupils told what they are to do (e.g. orally, written instructions)? How prescriptive are the instructions? How does the teacher collect evidence that the pupils know what they are to do? What scope is there for differentiation in the 'host' subject area and between pupils with different ICT skills?</p>	
<p>Pupil management How are pupils grouped? How does the teacher use their time during the activity? (e.g. Are they dealing with management issues or are they 'pushing' the pupils intellectually?)</p>	
<p>Intervention Does the teacher have to stop the activity for any reason? What is the purpose of the intervention? (e.g. To deal with management issues or to reinforce and/or direct learning?)</p>	
<p>Timing Is the time allocated to the activity appropriate?</p>	

<p>Follow-up What discussion of the activity takes place at the end of the lesson? How is the activity to be followed up in subsequent lessons?</p>	
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Table 2.3 Observation of a computer-based activity: pupil focus schedule

Focus	Observation
<p>Purpose of activity What evidence is there that the purpose of the activity is clear to the pupils?</p>	
<p>Content of the activity How do the pupils find out what they have to do? What evidence is there that the pupils know what they are to do? Do the pupils have a say in the content and/or direction of the lesson?</p>	
<p>Software Do pupils understand how to use the software? Note any problems they experience.</p>	
<p>Pupil grouping Do the pupils work collaboratively? Do boys/girls share equally in tasks? Are some pupils passive passengers – or given menial tasks to do by the other members of the group? Do pupils stay on task?</p>	
<p>Intervention Do pupils seek teacher help? Do pupils seek peer help? For what purposes is help sought (e.g. with software, with instructions, with ideas)?</p>	
<p>Timing What kind of work is set for those pupils who finish early (e.g. more of the same or different – and extending)? What happens to those pupils who do not finish the task? Are they given additional opportunities?</p>	
<p>Follow up Are all the pupils engaged in consolidation / discussion? What evidence is there that the pupils are aware of what they have learnt?</p>	

Skills and capability

In this section I discuss the skills teachers need in order to start to use new technologies in their teaching and the ways in which they can develop them. While the possession of some basic skills is required in order to use new technologies in teaching, software skills alone are not sufficient – they need to be allied to a sense of ‘capability’. Further, teachers do not need to be software experts before they start; valuable classroom activities can be devised using very simple skills. Indeed, one of the best ways to develop your skills is through using them in the classroom.

Basic skills

In teaching one needs software skills for two main purposes:

- to prepare classroom materials
- to devise activities for pupils to use in lessons.

The former mainly involves the ability to search the internet and CD-ROMs for information, using e-mail to communicate ideas with other teachers and word-processing and presentation software to produce printed and electronic worksheets.

The software in this list can also, of course, be used to produce effective classroom activities. Examples are given in the ‘Management’ section below. However, the range of activities teachers can devise and use will be significantly enhanced if they also develop the ability to use spreadsheets and databases together with any specialist programmes for a specific curriculum area.

Table 2.4 lists the essential ICT skills for each of the main types of software.

Table 2.4 List of essential ICT skills

This list details the minimum ICT skills you will need to begin to use new technologies in your teaching. It has deliberately been kept as short as possible and is limited to only the most essential skills. You will find that they are easy to acquire and, although basic, allow you to produce interesting classroom material. They should also give you the confidence to develop further.

All new teachers in the UK have to meet a more comprehensive list of capabilities and, when you feel you meet the essential skills listed below, you could usefully assess yourself against these. They are contained in Annexe B of the ‘Standards for Award of QTS’, and can be downloaded from: <http://www.canteach.gov.uk/info/library/circular4-98/Annexb.doc>

General: you need to be able to

- load and run software, including from a CD-ROM;
- delete and rename files and move and copy them both to a different location on the same machine and from one machine to another;
- open, save and print files using word-processing and presentation software and a spreadsheet;
- copy information from one of these applications to another.

Using a word processor: you need to be able to

- create a new document, including creating one from a pre-existing template;
- enter and amend text, including using a spell-checker;
- change the size, font and justification of text;
- create and modify tables, including changing the number of rows and columns they contain;
- create and format headers and footers;
- insert a picture into a word-processed document and change its position and size.

Using presentation software : you need to be able to

- run an existing presentation;
- create a new presentation, including using a 'design template' or 'auto content wizard';
- amend the content of an existing presentation, including the size, font, justification and position of text;
- create text boxes on a slide and enter and amend text;
- insert a picture into a slide;
- create links between slides;
- animate transitions both within and between slides.

Using a spreadsheet: you need to be able to

- create a new worksheet, including using one from a pre-existing template;
- enter text and numbers in cells and amend a cell's existing content;
- format cells, rows and columns, including creating borders around selected cells;
- create formulae to add, subtract, multiply and divide the contents of cells, rows and columns of data;
- be able to copy a formula from one cell to another so that it still functions in the new location;
- use the 'chart wizard' to create a variety of graphs (e.g. pie, scatter, column) from appropriate sets of data.

Using the Internet: you need to be able to

- access a website given its URL;
- store names and addresses of webpages as 'bookmarks' or 'favourites';
- navigate the internet by using links on a website and the forward and back buttons on a webbrowser;
- use a search engine (such as <http://www.google.com>) to find specific information on the internet, including being able to narrow down and extend searches using the logical operators AND and OR.

Using e-mail: you need to be able to

- to set up a web-based e-mail account with a provider such as 'Hotmail';

- read, reply to and forward to others e-mail messages sent to you, including messages with attached files;
- compose and send e-mail messages, including messages with attached files.

Using a database

The most common database found in UK schools is Microsoft 'Access' and the learning curve for this is almost vertical. My advice, therefore, is that if you are a beginner, do NOT use 'Access'. If you have other database software available (including 'Excel') then should learn to:

- search an existing database for information, including being able to narrow down and extend searches using the logical operators AND and OR;
- add new records and amend old ones in an existing database;
- create a new database, selecting types of fields appropriate to the data being entered.

Activity 2.5

Read the statements in the Table 2.4 and use them to assess your skills in each area.

One other point about software skills is crucial: they are a 'moving target'. Each year new software is produced and existing software appears in new versions which have ever greater capabilities. However the 'up-side' of this is that these changes almost always make the software easier to use.

Finally, and in order to improve one's 'street cred' with pupils, the one software skill needed is not on the list above, although perhaps it should be: it is the ability to write and send SMS messages without looking at one's mobile phone!

Capability

However, skills by themselves are not sufficient. Just as one learnt how to use different degrees of formality in written text, according to the circumstances, so it is also necessary to learn how and when to use technical skills. In the UK this knowledge is called 'capability' and it is capability, rather than software skills, which forms the basis for the UK National Curriculum in Information Technology (see <http://www.nc.uk.net/>).

Here are some examples:

- Many children (and adults), when they discover that every word on a poster or leaflet can be made in a different font, decide to use many different fonts. The

result is usually unreadable, and the clash of typefaces distracts from, rather than enhances any message that the author wishes to convey.

- It is possible to construct 'PowerPoint' presentations in which every word or letter appears from a different direction, accompanied by a different sound. Having learnt how to do this, many children and adults find it difficult to resist producing presentations which contain all these technical gimmicks. Any novelty value this might have quickly wears off and the demonstration of technical ability gets in the way of the message the presentation is aiming to convey.
- One of the tasks I set my trainee teachers is to construct webpages to introduce themselves to the schools in which they will teach. Many of my trainees have excellent software skills and some find it hard to resist the opportunity to demonstrate these in their work. The resulting webpages are often so full of pictures, 'JavaScript', sounds and animations that they take a very long time to download over a telephone connection. As a result, they tend not to get viewed frequently.

What these examples have in common is that a demonstration of software skills has been given a much higher priority than the needs of the audiences or consideration of how the message might best be conveyed. Skills have taken precedence over capability.

Start simple

It is not necessary to be a software 'expert' in order to start using ICT effectively in teaching. For example with very simple word-processing and presentation software skills, teachers can create effective worksheets and presentations. The effectiveness of these will depend more on the thought given to their content and the ability to convey a message rather than any in-depth knowledge of 'Word' or 'PowerPoint'.

One of the first activities I myself devised was to help Advanced level students understand chemical equilibria better. I simply presented three rows of data with equilibrium concentrations for hydrogen, iodine and hydrogen iodide (see Table 2.5).

Table 2.5 Equilibrium concentrations for hydrogen, iodine and hydrogen iodide

Hydrogen	Iodine	Hydrogen Iodide	K1	K2	K3
4.56	0.74	13.54			
3.56	1.25	15.59			
2.25	2.34	16.85			
0.48	0.48	3.53			
0.50	0.50	3.66			
1.14	1.14	8.41			

In the top cell of columns K1-K3 the students had to enter a putative formula for the equilibrium law expression and then copy it down to see if it gave the same value in each case. The chemistry involved is relatively advanced but the software skills involved are very simple – just entering formulae and copying them down a column. Yet this idea proved very effective in helping pupils understand a tricky bit of chemistry.

Developing skills through use

Once teachers have mastered the basic skills of opening, closing, creating and amending documents in the main software packages, it is better to spend time developing an understanding of what each software package can do rather than simply adding additional skills to your repertoire. For example, learning that most word processing packages can now be used to create webpages; that 'PowerPoint', which is normally used for linear presentations, can also be used to create multimedia products with complex interconnections between pages; that 'Excel' can be used as a database etc. For two main reasons this is far more important than learning another set of keystrokes:

1. The greater the understanding one has of the nature of these products and what they can be used to create, the greater the range of classroom activities one can devise.
2. As one moves, say, from one word processor package to another, one will find that the menus and keystrokes used to create any given effect change. What changes far less is what one can do with the type of software. If users know what a

certain type of software (e.g. the word processor or a spreadsheet application) can do, it is relatively easy to find out how to do it on any given package.

These higher-level skills, like all others, are best learnt in a context. For teachers, this means learning to use the skills within their own subject area. The UK government has allocated 250 million pounds – money raised by the National Lottery (!) – to pay for in-service training to develop teachers' skills in new technologies. This huge project has been evaluated by the Office for Standards in Education. OFSTED (2001) found that the most effective training involved teachers learn skills in subject-specific contexts.

As teachers start to use their developing skills to produce materials, they will start to ask, "I wonder if I could ...?" and this will provide the motivation for further exploration of the ways in which different types of software can help to produce the classroom materials they wish.

One way to develop skills in this way, and to learn better the capabilities of different kinds of software, is to take the ideas of other teachers and adapt them. In the UK the National Grid for Learning (see <http://www.ngfl.gov.uk/>) has a 'Teacher Resource Exchange' (see <http://contribute.ngfl.gov.uk/>), to which any teacher can post an idea for a lesson activity involving ICT. This now contains thousands of ideas for activities. As there is no quality control, not all of these are good. Nevertheless, the Teacher Resource Exchange is still an extremely valuable resource, not least because teachers can often find the germ of an idea which they can develop further. For example, one of my ex-trainees posted a spreadsheet for recording and displaying coursework marks. I downloaded her ideas from the site, examined it and then adapted it so that it predicted pupils' final examination grades on the basis of any coursework they had completed. I then posted this new spreadsheet again. My version was adapted in turn by another ex-trainee who made it much more user-friendly.

Management issues

In this section different ways of organising and managing classroom activities using new technologies are discussed together with examples from practice. This involves two related but distinct issues:

- how to organise the distribution of children between the available technology; and

- how to organise the distribution of computers within a school.

Although teachers tend to be predominantly concerned with the former, it is important that they have an informed view of the latter, since the way schools choose to distribute hardware determines – to some extent – the range and types of classroom activities available to teachers and pupils.

Classroom organisation

The kinds of pupil organisation common in many lessons consists almost certainly of a mix of individual, group and whole-class activities. As noted above, the same basic pedagogic principles apply with the use of new technologies. One should, therefore, aim for a variety of types of pupil organisation and activity. Just as teachers should not use computer-related skills just because they possess them, so pupils should not work individually just because they can. Teachers can use new technologies in their lessons in a variety of ways, for example:

- the teacher using a single computer;
- one pupil using one computer;
- all pupils in a class using a computer each;
- one group of pupils using one computer;
- all pupils in a class using computers in groups – one computer per group; or
- all pupils in a class using computers in groups – more than one computer per group.

Each of these possibilities is illustrated by examples below. Most of these are examples of good practice, but since one can also learn from bad practice – as long as one recognises why it is bad – there are also some examples of what *not* to do.

Activity 2.6

Before reading further, think of activities in your own subject area that use each of the methods of organisation listed above. Try to think of as many different kinds of activities as you can for each method.

*Examples of use*The teacher using a single computer**Example 2.1**

In their art lessons pupils had been producing animated 'PowerPoint' presentations using graphics they had designed themselves. The teacher wanted to share examples of these presentations with the class. He felt that it would take too long to get each pupil to demonstrate their work on the machine connected to the display monitor, but as the computer suite had software that allowed him to control what each pupil saw on their screen, he used this to show the whole class what individual pupils had on their own machines, while providing a commentary to point out the good features of each pupil's work.

Example 2.2

To introduce a Personal Social Education (PSE) lesson in which pupils were asked to discuss the ethical issues involved in genetic engineering, a teacher produced a 'PowerPoint' presentation. The classroom had an interactive whiteboard allowing all pupils to see the presentation, which listed precisely what they had to do in the lesson. While the presentation looked very professional, the teacher did not check that the pupils had remembered what he wanted them to do, so that by the time they returned to their individual computers, they had forgotten the complicated list of instructions they had been given. As a consequence, the class was filled with confused pupils asking for individual help.

This illustrates the pitfalls of demonstrations. Just because a 'PowerPoint' presentation looks professional, it does not follow that pupils will learn from it. This is an example of style taking precedence over good pedagogy. No matter how good a lecture-demonstration looks, it is still a lecture-demonstration.

These two forms of demonstrations have different strengths. The use of a display screen makes it easier to have a class-discussion based on what the pupils are seeing. This is much harder to organise when the pupils are all looking at different screens. Discussion is made easier with some forms of new interactive whiteboards which allow pupils to use wireless handsets to send information to the screen from anywhere in the class. On the other hand, in order to illustrate a point it is often useful to show

all the pupils what one person has done. This is best done by sending the person's work to all the monitors in the class so that the pupils can see it from where they are sitting.

One pupil using one computer

Example 2.3

A history class was doing coursework related to life in the Elizabethan period. The class had many reference books and other printed resources available and also one computer running a CD-ROM with information about the period. The teacher had discussed with the class the kinds of information they could obtain from the various resources available to them and, when they needed the information on the CD-ROM, they used the single computer to search for and find it.

Example 2.4

In a science lesson there was a carousel of practical activities concerning the construction of electric circuits. One activity was computer-based: the pupils used the software package 'Crocodile Clips' (see <http://www.crocodile-clips.com/>) to construct virtual circuits and compare the results predicted with those obtained from experimentation.

The main question raised by this way of using new technologies is organisational: not all topics are suited to the methods used in this example and it takes time and careful organisation of other resources to ensure that pupils benefit.

All pupils in a class using a computer each

Example 2.5

Each pupil in a class wrote a webpage about themselves for the school Intranet. In previous lessons they had discussed who the audience for their pages would be and what features they could put in their pages to appeal to this audience. As pupils worked they looked at each other's pages and when they saw something they particularly liked they asked the other pupil how it was done. Twice the teacher stopped the whole class: once because he saw a pupil use a technique to position a picture on the page he did not understand; the other time because he had heard a number of pupils asking each other the same question. On the first occasion he asked the girl who had positioned the picture to explain to the class how she had done it. On

the second occasion he asked for a volunteer to answer the question he had heard other pupils ask.

In this example, the teacher clearly is not the source of knowledge in the class but, nevertheless, the class would not be learning as well without him. The pupils are working on their own, helping and learning from each other, and the teacher is intervening to facilitate learning.

Example 2.6

The school had bought 'Successmaker' (see <http://www.successmaker.com/>) which is a so-called 'Integrated Learning System' designed to enhance pupils' basic skills. As they entered the class the pupils logged onto the machine and continued with the programme from where they had left off last time, working silently and not interacting with one another.

Here the computer became a substitute for the teacher and this has numerous drawbacks. For example, for many pupils the purpose of the lesson becomes the need to complete a set number of screens, rather than learning anything. In this it is analogous, for example, to worksheet-based incremental schemes. Another drawback, which is at least as important as the first, is that by working individually the pupils do not learn how to work together and from each other. (For a more detailed discussion of Integrated Learning Systems see Cole 1999.)

All pupils in a class using computers in groups – one computer per group

Example 2.7

A class of pupils had worked in small groups for three lessons to find information on the internet about volcanoes to produce 'PowerPoint' presentations of five minutes. In the fourth lesson they showed their presentations to each other, each group in turn using the computer attached to a display monitor. The possible problem with this kind of activity is that, since each pupil is only presenting for five minutes, they will get restless just watching others, which they might consider wasting time. The teacher who organised this activity was aware of this problem and, therefore, combined it with an evaluation activity. Each pupil was given a simple form on which she had to evaluate every presentation she saw. This evaluation activity was taken extremely seriously by the pupils and it gave the teacher valuable feedback on pupil learning.

For example, almost all the pupils rated presentations highly in which the slides were full of words because 'they contained a lot of information'.

This is an important type of activity. When working with traditional media, teachers recognise the importance of displays of classroom products and most classrooms contain posters and other materials produced by pupils. However, many computer-based classroom products are simply kept as files on machines and not seen by anyone other than the creator and the teacher. Therefore, giving pupils the opportunity to show to others what they have produced is important.

Example 2.8

In a science lesson the pupils were trying to determine the formula of magnesium oxide by burning magnesium in air and weighing it before and after burning. At the start of the lesson the teacher discussed with the class the measurements they would have to take and how the formula of magnesium oxide could be calculated from them. They then constructed a spreadsheet to calculate a formula for the compound from the class results. As each group of pupils finished the experiment they entered their results in the class spreadsheet. At the end of the lesson the teacher discussed the results with them and printed out a copy of the complete spreadsheet for each pupil.

This again is a valuable activity. Calculating the average of the class results by hand would take the pupils a considerable amount of time and shift their focus to the simple, but numerous calculations required. By using a computer to do the calculation the teacher was able to spend more time discussing relevant scientific matters with the class.

All pupils in a class using computers in groups – more than one computer per group

Example 2.9

A class was divided into groups and each group had the task of creating a newspaper. The pupils had been given a template which told them the sections the newspaper had to contain and gave them a list of newspaper and TV internet sites where relevant information could be obtained. Their initial task was to divide the various jobs between themselves.

This kind of activity allows each pupil the opportunity to use technology in a meaningful way while also emphasising collaborative skills.

There is one danger, though. The initial group discussion by the pupils to allocate tasks is very important and needs careful organisation. I saw one class, for example, where the teacher did not emphasise this enough and in some groups all the pupils worked as a single group on one machine, doing the tasks sequentially. As a result, most of the pupils did little or no work in the lesson.

Activity 2.7

List the kinds of activity you have used with pupils in the course of a term and issues associated with each of them.

For the following term, devise and teach lessons incorporating the kinds of activity you have not already used.

Organising the distribution of computers within a school

There are three basic ways in which schools organise the distribution of computers within their teaching areas:

- in purpose-built computer suites;
- one or two machines in each teaching area;
- centrally held class sets of portable notebook machines.

The relative advantages of each of these are listed below. As the price of new technologies is continuously decreasing, schools are increasingly adopting a 'mixed approach' using all three methods of organisation.

Computer suites have organisational advantages and pedagogic disadvantages. A computer suite makes it possible to organise lessons in which all pupils are working on computers at the same time (although not necessarily all doing the same thing), which presents fewer management challenges to teachers compared with having only one or two machines in a teaching room. Suites also have the economic advantage that expensive equipment, such as interactive whiteboards and data projectors, can be permanently housed in them and be available to all users. However, they suffer from significant pedagogic problems. For instance, since the pupils have to move from their normal teaching space to the computer suite for 'the computer lesson', the use of new technologies can easily become – or be perceived as – a 'special event' and is, therefore, not properly integrated into the pupils' teaching/learning experience.

Giving all classrooms access to new technologies by placing **one or two machines** in each has pedagogical advantages and organisational disadvantages. If new technologies are always present in the classroom, they more easily become part of the pupils' everyday school experience. However, if, as is usually the case, there are only one or two machines available in a room, then this places significant organisational demands on the teacher and also restricts the range of classroom activity possible. Should the teacher wish to use equipment such as an interactive whiteboard, this will need booking, moving to the room and setting up in advance of the lesson etc.

The use of **class sets of portable computers**, utilising wireless connections to the school network, combines the many pedagogic advantages of classroom-based machines with most of the organisational advantages of computer rooms. Because they do not need to be physically connected to an electricity supply or the school network, they can be used anywhere in a classroom and thus give the teacher the greatest flexibility in deciding how to use the technology. Their major disadvantage is economic: because they are less robust than desktop machine and are moved around more, they will need replacement more quickly than desktop machines. This is partially compensated for, though, by the lower cost of installing a wireless network in a school compared with routing cable through an existing building.

Summary

New technologies promise much but also demand much of the teacher. Central to their promise is the opportunity to use new tools to achieve old pedagogic aims – an enhanced focus on pupil learning and the active involvement of pupils in that learning, not least through the use of new forms of collaboration, where pupils learn with and from each other. Central to the demands on the teacher is the necessity to reconsider her role in the classroom and the development of new pedagogic practices, including innovative forms of classroom organisation. In order to use technology effectively, teachers have to possess – or acquire – some basic skills, but once these simple skills have been mastered, the crucial factor is a willingness to experiment. 'Playing' with the software allows the teacher to imagine a greater number of uses for it in the classroom. Teachers, like pupils, learn best by doing, and then reflecting on

that doing. If technology is used effectively, that 'doing' will be *with* rather than *to* the pupils.

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