2004 Report: ICT in schools – the impact of government initiatives

Secondary design and technology

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Introduction

This report is based on subject-specific evidence from visits to secondary schools made as part of the inspection of the impact of government ICT initiatives between April 2002 and December 2003 and has been supplemented by evidence from other school visits where appropriate. This contributed to the main report, *ICT in schools*, which is available from the Ofsted publications centre (07002 637833) or via the Ofsted website (www.ofsted.gov.uk).

Main findings

- Secondary design and technology (D&T) departments continue to make widespread and effective use of ICT in their teaching.
- Increasingly, pupils are developing competencies in:
  - using the internet to carry out investigations
  - recording ideas and information using attractive graphics
  - simulating and modelling ideas as they develop solutions to problems
  - using computers and related machinery to design and make products to high levels of sophistication
  - using computers to control systems.
- The best use of ICT is that which is seamlessly integrated into normal teaching procedures, and used routinely and confidently by both teachers and pupils.
- Despite these gains, curricular planning for the progressive acquisition and application of ICT skills in D&T is generally weak in schemes of work, especially at Key Stage 3.
- Good ICT use improves: pupils' motivation; access to information; capacity to record ideas; and the ability to design, control and make to high levels of precision.
- Less effective ICT use can: make it difficult, in assessing attainment, to separate the achievement of the pupils from the capacity of the software; promote the uncritical recording of unnecessary information; create general class management problems where equipment is inadequate or unreliable; appear to pupils to be divorced from main D&T activity; or dress up low-level work in sophisticated presentations.
- The most effective schools recognise that D&T applications are many and various, requiring training, curriculum and staff development and resourcing which are specific to the subject.

The impact of the initiatives

Teaching and learning in design and technology

Secondary D&T departments continue to make widespread and effective use of ICT in their teaching. The best use of ICT is that which is seamlessly integrated into the normal teaching practice and used routinely and confidently rather than inconsistently or as a novelty, for example in isolated and infrequently used computer aided designing and computer aided manufacturing (CAD/CAM) suites. In a small number of departments, strenuous efforts have been made to encourage all teachers to use ICT consistently and with high levels of success. In effective departments, lessons are well planned to make the best use of ICT. This takes training and practice together with adequate access to hardware and software. Many schools have these advantages but many do not and are consequently unlikely to realise the expected benefits of using ICT in teaching and learning in D&T until this is redressed.

CAD/CAM has been a major development that has stimulated much successful work in D&T. However, teachers have to cover basic skills with the software before pupils are able to use it confidently and creatively, as they did in this example, in which a Year 7 class learned to use CAD software:

> *The teacher was very skilled in demonstrating the basic tools of the package and this provided a sufficiently firm foundation from which pupils could confidently begin their first drawings. The teacher used a range of methods to reinforce the learning, including individual coaching, additional demonstrations to small groups as needed and handouts encouraging pupils to work with some independence. Progression was carefully built into the lesson: as it unfolded, a range of software tools was explored and pupils added dimensions to their drawings, worked to scale and used gridlines. By the end of the lesson, all pupils had a good grasp of the basic tools within the package. Pupils were keen to learn more and looked forward to the next lesson.*

The following example underlines the need for careful planning. In this lesson, Year 7 pupils used CAD to design a chocolate mould by removing material from a solid block on screen:

> *The end result was downloaded to a computer numerically controlled (CNC) router. A test piece was machined in wood prior to the final product in plastic. This was ambitious and sophisticated use of software and CNC equipment and pupils showed a good and growing expertise in ICT. However, a shortfall in classroom management meant that most pupils had to waste time queuing to take their turn on the department's single CNC router.*

In Key Stage 4 and post-16 in particular, skilful teaching is required for this sophisticated software, such as that seen in the following Year 11 engineering GCSE lesson which took place in a recently refurbished and equipped CAD/CAM room. The project was to design the body for a mobile phone:

The lesson began with clear objectives written on the whiteboard and discussed with the class: to develop skills in extrusion, rounding corners, dimensioning, deforming faces. The teacher supplemented his clear data projector presentation with a detailed booklet produced in the school on techniques to use with this software. This helped pupils to work independently. The teacher had a good, encouraging rapport with the class, engaging all pupils well through precise questions with which he punctuated his clear explanations. They made good progress throughout and quickly developed the capacity to use: the spline tool to create curves; the delete line segment tool to remove unwanted lines; the extruding tool to create three-dimensional forms; and the round edge tool.

D&T teachers often make effective use of generic ICT applications, for example to improve presentation and exposition. Where funding has been available, the use of multimedia software to illustrate explanation and electronic whiteboards to increase pupils' involvement is proving very beneficial. In this example of a Year 11 food technology class, pupils used computers and digital cameras to record their disassembly and analysis of commercial food products (such as chicken tikka) as part of their major GCSE project:

The lesson was very well planned with detailed learning objectives to cover the accurate recording of precise information, the use of a range of ICT skills and the drawing of inferences from the disassembly exercise to support the subsequent development of the pupils' own food products. The teacher introduced the lesson, set to work those who were ready to work alone and then gave other pupils small group coaching on how to include and label digital photographs, produce exploded diagrams and annotate text. Pupils gained a good insight into the value of this disassembly task and could explain how this should help them develop their own products. They used computers skilfully and produced lively, illustrated accounts of their precise analyses.

Despite such good examples of specific ICT use, longer-term planning for the progressive acquisition and then application of ICT skills over a year or a key stage is not sufficiently embedded in most schemes of work, particularly in Key Stage 3.

As reported in the past, assessment is a weaker aspect of teaching and teachers continue to find difficulty in discriminating between the genuine development of pupils' D&T capability and the appearance of capability brought about by the sophistication of the software. Teachers need detailed guidance on this issue and, since there is little research or other evidence on which authoritative guidance can be based, there is a need for basic developmental work to be completed by the appropriate agencies.

When it is available, skilful technician support is well managed and highly valued by teachers, partly in setting up and maintaining systems and partly in offering tuition and assistance to individual pupils on the use of software or CAM equipment. Technicians who have undertaken specific ICT-related training are particularly effective. However, even in most of the very best departments, the availability of technician support is too little and it has not kept pace with the growing ICT-related demands on their time. In some technology colleges, additional funding is being used well to make up for this shortfall.

Overall, the effective use of ICT in teaching brings the following benefits to the development of pupils' D&T capability:

- increased self-esteem and motivation, especially among boys
- access to information for project investigations
- the capacity to record and present information in a clear and sophisticated manner
- the capacity to develop design ideas free from the constraints imposed by hand methods of drawing or modelling ideas
- the capacity to simulate and control systems
- access to precise and replicable means of making complex objects.

However, ineffective use of ICT can have a number of negative consequences, including:

- the difficulty of distinguishing the work of one pupil from that of another, or the creativity of pupils from the functional characteristics of the software
- a temptation to record information and ideas with too little analysis of their usefulness
- classroom management problems where equipment is insufficient or too unreliable to enable pupils to work at an acceptable pace
- a lack of impact on pupils' D&T capability because it is taught as a 'bolt-on' extra to courses rather than as an integral part
- apparently sophisticated use of software which can hide the fact that pupils may be using it for trite or low-level D&T work.

Standards and achievement in design and technology

ICT continues to be used widely and successfully to improve pupils' capability in D&T. In order to meet National Curriculum requirements in both Key Stages 3 and 4, pupils are expected to use ICT to:

- retrieve, record and analyse information during their investigations and evaluations
- design, model and simulate as they develop their ideas
- make and control products and systems.

These expectations are raised further in the 16–19 phase.

Pupils' achievement using ICT has increased considerably in recent years. This was initially restricted to general applications which aided the recording and presentation of information such as word-processing and graphics. While these remain important, they

have been widely supplemented within four broad areas: information retrieval; simulation; CAD/CAM; and control.

Half of secondary school D&T departments are now able to give pupils controlled and ready access to the internet to supplement other sources of information as they carry out investigations. Where the subject is well taught, pupils are encouraged to seek information which is sharply focused on the D&T task in hand. They then draw upon this in order, for example, to evaluate the effectiveness of existing products, clarify a specification for a product, draw upon what they have found to generate or develop their own ideas, or analyse technical data on the appropriateness of particular materials for a specified purpose. Effective use of the internet can bring considerable realism and motivation to D&T work, as in the following example from a Year 10 class in an inner-city school:

> *Pupils were introduced to the task – design and make a perfume bottle (concept model) and packaging based on 'retro' styling. This lesson, which takes place in the on-site City Learning Centre, focuses on research into design influences to help pupils to generate and develop their own design ideas better. Each pupil has personal access to the internet. Their searches are made very purposeful by the teacher's clear introduction and supporting handout; the latter includes appropriate words and phrases for internet searching and helps pupils to find five useful websites containing sources of 'retro' design images. Pupils readily select, cut and paste images from the website into word-processed documents and then critically annotate them. They are aware of copyright and know that designers need to take account of the costs of images obtained to use in a commercial context. They focus on image, lettering and stylistic features; some concentrate on particular periods, such as the 1920s and 1970s, while others search a range of websites before deciding how to proceed. The lesson draws upon and reinforces existing ICT skills and improves pupils' understanding of how designers use research to gather ideas and develop their designing capability.*

Pupils make increasingly effective use of the internet and CD-ROMs to retrieve specific information and data for D&T projects, especially in Key Stage 4 and beyond.

Able pupils, in particular, evaluate the information so collected and make practical use of it, for example in formulating design specifications, developing design ideas and comparing the suitability of materials, ingredients and components for the products they intend to make. The following example relates to a Year 9 textiles lesson:

> *Pupils used the internet to find images of clothing as a prelude to beginning to design caps, T-shirts and shorts for their current project. They used the images collected to create 'mood boards' reflecting the set theme for the project of holiday wear. The teacher's good preparation of guidance notes helped pupils to open a new page on screen, change to landscape format and then cut and paste images from the internet. Pupils quickly became adept at resizing the images and arranging them on the page. They then opened and formatted text boxes to annotate their pages. Pupils were competent in using search engines with simple queries to locate appropriate images.*

There is a tendency for less able pupils, and boys especially, however, simply to cut and paste with little attempt to appraise or interpret the information they gather.

Questionnaires are often devised and analysed using ICT but, especially at Key Stage 4, they are often trivial and seemingly carried out merely to meet coursework assessment requirements. Email is less frequently used.

Before the advent of accessible software for simulation in, for example, food technology or electronics, many pupils found it difficult to experiment with a range of design ideas. Often in electronics, the thinking underlying the development of circuit designs was slowed down by the need to try out the ideas by assembling components from time-consuming and sometimes unreliable kits. The widespread use of specific ICT simulation software has freed pupils from this constraint. They are able to quickly test out their design ideas on screen and the consequences of their decisions become immediately apparent. This encourages pupils to think as designers and it improves the pace of their learning and productivity, as in the following Year 11 example from a GCSE course in systems and control:

> *Midway through their designing for the major project, pupils were using commercial software to model, evaluate and, in the case of the abler ones, design electronic circuits on the theme of a burglar alarm to be displayed for advertising purposes on a store counter. Most had developed a circuit to meet their individual specifications and were importing this into commercial printed circuit board (PCB) software to develop the circuit and finalise its layout. Each pupil had individual access to a computer in this well-equipped ICT room in the D&T suite. A wide range of circuits and PCB layouts reflected the intense individual concentration of pupils supported by effective prior learning of the functions of components and helpful, clear instruction sheets produced by the teachers. The software has enabled much experimentation as pupils have explored circuits and modelled changes. It has removed much of the frustration experienced in the past by having to model such ideas using relatively unreliable equipment, a point made with some feeling by the D&T teacher. ICT is enabling pupils to think more clearly and achieve more than they did in the past.*

The uses of CAD/CAM continue to grow and contribute to pupils' D&T capability. In Key Stage 3, simple two-dimensional CAD software enables pupils of all abilities to develop design ideas and present them effectively. Where schools are adequately resourced for CAD/CAM and teachers are competent in its use, many pupils use the new technology to develop design ideas, present them in industry-standard ways and make small products to very high levels of precision, levels which can be replicated in volume production of the products. This increases pupils' motivation and strengthens a school's capacity to teach aspects of the industrial context of D&T in realistic ways.

The new software needs to be used selectively. The use of CAD is more effective in raising pupils' performance as they develop ideas in detail rather than as they conceive basic ideas initially: the latter is best carried out with more traditional means of design sketching or model making.

The use of ICT to control systems continues to be an underdeveloped part of D&T. At Key Stage 3, control is usually restricted to small-scale units of work using purchased kits, for example:

> *A Year 9 class explored the use of a control kit for the first time, on this occasion to control a light and a motor in sequence. The introduction was crisp, pleasant and*

pacy. Pupils then had to type a control sequence step by step under the teacher's close supervision. All pupils achieved a working sequence and were motivated by this success. Some were able to extend the sequences and discuss real-world applications, such as how the light could be made to signal SOS or how it compared with the way central heating systems are controlled.

Older pupils are increasingly able to use programmable chip technology, although this is still rare and its progress is hindered by a lack of teacher expertise in many schools.

Any discussion of standards and achievement of pupils in D&T using ICT is not without its difficulties. A critical issue in designing with computers is the extent to which the resulting designs are an indication of the pupils' D&T capabilities rather than a function of the sophisticated software. In extreme cases of the latter, the designs resulting from the pupils' work are not dissimilar to those they might have copied from someone else. This is a matter of critical importance which the subject community needs to address if pupils' CAD work is to achieve widespread acknowledgement as their own work. Similarly, while effective use of a range of ICT software enables pupils to present their ideas in an adult and sophisticated way, teachers need to grapple with the problem of distinguishing pupils' competence in presenting ideas from that of the computer system.

Overall, when ICT is well used in D&T, it improves pupils' productivity, the quality of their research and designing, and sometimes the originality of their work, the technical sophistication and precision of their manufacturing and their capacity to control systems. When not well used or where expectations are low, ICT can have the opposite effects; it can also convey a spurious impression of D&T capability which, on close analysis, is more a reflection of the capacity of the hardware and software than it is of the skill of the pupils.

Implementation in schools

Leadership and management

Where ICT is very well used in D&T, this is closely associated with clear vision on the part of the school's leadership and the drive to develop ICT in teaching and learning throughout the school, in conjunction with an effective ICT co-ordinator and a determined head of D&T department. This is usually accompanied by careful planning and implementation of rolling programmes for ICT within a school's overall planning for improvement. Such support is at its most effective when it covers the curriculum, resourcing, management and evaluation cohesively and is supported by a cross-curricular team of staff which plans and advises on ICT development. In this context, those in charge of ICT teaching, both generally and in the D&T department, are not only supported but held accountable for ICT development and its influence on pupils' standards of achievement. A minority of heads of D&T departments make effective use of ICT in schools where senior management leadership is less strong and drive developments on their own; but where senior support is lacking, inefficiencies and frustration creep into the development process. For example, tensions continue to

surface in many schools because D&T staff and pupils often need easy and quick access to small numbers of online computers in D&T suites rather than whole-class access to a general computer suite that is not always readily available.

Staff development

In the more effective D&T departments most, but rarely all, teachers are competent general users of ICT, having benefited from a range of external and internal development and training opportunities. Most have invested a considerable amount of their own time in reaching these levels of capability. Typically, ICT capability ranges from the competent use of computers for administration, email and preparing learning resources to the effortless use of data projector presentations and electronic whiteboards to stimulate pupils and authoritative use of more specialised software in control, simulation or CAD/CAM. Less commonly, D&T teachers use ICT systems for the efficient recording, retrieval and analysis of assessment data on their pupils' performance. Access to laptops for use at home is a key factor in enabling teachers to practise and develop their general and specialist ICT skills for use in their teaching. This has been helpfully increased by the Laptops for Teachers scheme.

Few D&T departments had their training needs adequately met by NOF-funded training. This was usually pitched at too general a level covering basic applications software and generic pedagogy. Many D&T teachers did not complete this training because of its inadequacies. The most effective training took place where departments clearly identified the subject-specific aspects of ICT which they intended to develop and then combined short externally-sourced courses with considerable in-school – and usually not funded – developmental and self-help work. D&T teachers in most schools which use ICT effectively have become proficient on the initiative of their head of department. Some LEAs have also added considerably to this, usually by providing a strategic vision for ICT in D&T, and backing this up with courses for teachers and technicians. Specialist schools' funding has also been a significant support for staff development in this field.

Technicians continue to provide significant support for D&T teachers, not least in ensuring that computer systems operate as required, partly by helping to set them up, but largely by maintaining and dealing with defects. The burden on technicians in D&T has been increased considerably by the expanding use of ICT and in most schools the level of technician support is not sufficient to meet the demands of the subject.

Resources and accommodation

Resources and accommodation have developed apace for the use of ICT in D&T in recent years, usually supported by a number of sources of funding, including NGfL, and often with significant levels of self-help from D&T teachers and technicians. In a well-equipped D&T department, for example:

> *There are 44 new computers, well placed for easy access especially to pupils using the rooms designated for resistant materials, systems and graphics. An extensive range of software is available and well used. Rooms have interactive whiteboards which enhance teaching well. The department has two networked computer suites,*

adjacent to these rooms and permanently available to groups when they are timetabled to work in them. Given the good planning, the spirit of co-operation in the department and the willingness of D&T teachers to change rooms when needed, the department gets good value from its computers, which are used very effectively in the subject.

The impressive developments in CAD/CAM have been heavily supported by DfES and private sector resourcing and an intensive implementation and training programme managed by the Design and Technology Association. This programme has brought industry-standard design software into many schools and a licensing agreement which enables pupils to install and use it on their home computers, thus giving them scope for further study. Even so, many schools remain unable to meet the National Curriculum requirements to include CAD/CAM in their courses. In a significant number of schools, a lack of resources, often accompanied by a lack of teacher expertise, continues to limit pupils' experience of work in computer control and CAM, particularly in Key Stage 3. Also, these resources can quickly become outdated. Thus, in the same school:

CAD/CAM equipment is distributed among workshops. It is 10 years old and not as much used as in the past. The head of department intends to update this provision if the school's bid for technology college status is successful.

Schools are generally making good use of e-learning credits. In one school, for example, the credits for D&T were spent to provide a good range of software for electronics, CAD/CAM, food technology (such as the study of nutrition) and general office applications.

Overall, there remains an unacceptably wide difference between the best and worst equipped departments and within different sectors of some departments. ICT resources continue to be a major issue in around a third of schools. This takes two forms:

- a general lack of equipment, especially noticeable in CAD/CAM, which is required by the National Curriculum to be taught in both Key Stages 3 and 4. There is also a widespread deficiency in equipment to teach computer control. This has sometimes been exacerbated by schools purchasing inappropriate machinery without having access to, or taking, authoritative and specialist advice
- the use of equipment with low levels of reliability, sometimes made worse by an inadequate supply of technician support.

The vast majority of D&T departments make good use of the equipment which they have. This includes extensive use by pupils in lunchtime and after school.