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ICT in Schools: Effect of government initiatives

Secondary Design and Technology

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1. This report is based on subject-specific evidence from secondary schools visits made as part of the inspection of government information and communication technology (ICT) initiatives between May and December 2001. This contributed to the main report, *ICT in Schools: Effect of government initiatives*, which is available from the OFSTED Publications Centre (07002 637833) or via the OFSTED web site (www.ofsted.gov.uk).

Effect of the initiatives

Summary

2. Overall, ICT is more widely and better used in design and technology than in other subjects. However, although the combined effect of the government's initiatives on the use of ICT in design and technology has been significant, improvements are more attributable to the increased attention to ICT than to specific NOF-funded training courses or on-line facilities provided as part of NOF-funded training. This is because other factors such as Specialist Schools funding and the computer-aided design and manufacture (CADCAM) initiative have often been more influential in promoting more effective use of ICT. This also helps to explain why the differences between schools remain considerable in relation to the attainment and achievement of pupils using ICT, the quality of teaching and the provision of resources. In nearly three quarters of schools the use of ICT in design and technology makes a significant contribution to pupils' achievement and in more than a half of schools teachers use ICT very effectively to promote that learning.

3. Computer-aided design and manufacture is a major and influential development that has stimulated much successful work using ICT. The revised National Curriculum required schools to ensure that pupils use CADCAM techniques. By far the most effective factor in developing the use of ICT in design and technology has been the provision of advanced 3D-CAD software, totally apart from nearly all NOF-funded training, but free of charge, and linked to completion of specific in-service training (INSET). This scheme was run by the Department for Education and Skills (DfES) and the Design and Technology Association (DATA). Almost two thirds of the secondary schools in England have been involved in the last two academic years. Associated computer-aided manufacture is increasing and improving, but at a much slower rate because of the lack of hardware resources in most schools.

4. There has been a marked increase in pupils' use of relevant web-based research as part of designing and of teachers' effective use of ICT-based teaching aids such as whiteboards or presentational software. The most significant constraint here is the lack of access to sufficient computer resources of appropriate power and associated peripheral hardware. Work with 'control' in systems, where components such as lights and motors are switched in response to external signals, remains

insufficient and rarely addresses the broader concepts of control, such as positive and negative feedback.

5. The National Grid for Learning (NGfL) funding is mainly used to improve whole-school infrastructure for ICT. Most design and technology departments benefit indirectly from better network and Internet access although in a few cases the new provision is less successful than previous arrangements. With the establishment of newer computer suites there is some transfer of older hardware to subject departments. This has very limited benefit to design and technology departments where higher-powered systems are frequently needed for graphics and other CAD applications. Where additional funding has supplemented NGfL sources to give departments access to broadband communications, pupils have quickly become adept at using Internet sources to research their design tasks, especially in Key Stage 4 and post-16.

6. NOF-funded training has generally had little direct Effect on design and technology teachers' capability in using ICT in their teaching. So far the training has been insufficiently differentiated or inadequately subject-specific. Those who already had good ICT knowledge, understanding and skills generally found that the training did not extend their competence any further, whilst those with limited or no ICT capability found that the training was insufficiently adapted to their own subject needs. Where the training was successful, it was most often the result of careful support by a well-organised school ICT co-ordinator or head of design and technology department. These tailored training to individual needs and organised crucial detailed in-class support for their colleagues during their first experiences of using particular software and hardware.

Using ICT in design and technology

7. Overall, as indicated above, there has been a steady increase in the use and quality of ICT in design and technology. Whereas formerly pupils only used general ICT applications to improve the presentation of their work, mainly using word-processing and charts in design portfolios, now a much greater proportion of usage stems from other applications. The use of CADCAM has again seen the greatest increase, closely followed by information searches on the Internet, designing using simulations and control applications.

Using CADCAM

8. Pupils make good use of 3D CAD software in an increasing proportion of schools. The most noticeable change in Key Stage 4 and post-16 design and technology has been the rapid development in the use of 'state-of-the-art' CAD software in most schools. The relevant licence agreements enable pupils to install the programs on their own computers at home, often leading to rapid progress by highly motivated pupils producing many high-quality examples of work. The development of teachers' competence has been rapid. Teachers have significantly developed their own expertise and suitable teaching materials. The potential for the software to be used to help pupils understand basic drawing systems such as orthographic projection is appreciated by most teachers. What has always been difficult, requiring many teaching aids, suddenly becomes straightforward, as pupils are able to manipulate 3D images and rotate them to see what the different views of

the image look like. Better progress is often made where pupils have previous experience, typically in Key Stage 3, with simpler 2D software. Both low and high-attaining pupils are able to make good progress as long as the teacher is able to monitor progress at the crucial initial stages. Some of the lower-attaining pupils appreciate, in particular, the lack of need to use text in the work.

9. Many pupils now use CADCAM techniques to improve the quality of design development and the accuracy of manufacture. They are able to visualise their products from the virtual information provided and make appropriate design decisions. When they use CAM facilities, standards of production and accuracy can be very high. At best, pupils realise the potential of producing elements of a design to very high standards of accuracy, that parts can be made to fit together precisely and that they do not have to be present during the production process when the machine is running. Pupils are pleased with what they achieve. Much of the work in CADCAM, however, remains at a low level because of low staff expectations of what can be achieved. In these cases the products are trivial and little real learning occurs.

10. The challenge for teachers using CAD continues to be to find out which aspects of designing are best tackled with CAD software genuinely to raise design and technology capability, rather than just the 'appearance of capability' shown by the production of sophisticated drawings. The early evidence suggests that CAD is more successfully used in 'design development' than for basic 'conceptual design' when pencil and paper or other forms of design modelling are better. Similarly, further work needs to be done to find out the most effective ways of teaching pupils to use the software to help them in solving design tasks. Suitable curriculum materials need to be developed that foster creative responses from pupils using these new designing and manufacturing resources.

> *In one lesson the teacher introduced Year 7 pupils to 2D CAD software so competently that not only did they learn to use the basic operations of the software but they also understood when it was appropriate to use this facility and when it was better to make quick initial design ideas with pencil and paper.*

Using the Internet for research and investigation

11. More pupils are now proficient in this form of information gathering, especially where access is easy and within the design and technology department. Although sometimes the work is trivial with pupils doing little more than unconsidered 'cut-and-paste' into design portfolios, more frequently the web is now used as a genuine source of information for both the design and the manufacture of products. It often provides a much-needed industrial dimension to pupils' work. Pupils are able to use multimedia presentations to present their ideas more effectively, as in the following Year 12 GNVQ manufacturing lesson:

> *Students were able jointly to communicate their perceptive design research findings, skilfully analysed using a spreadsheet, working together to incorporate high-quality and effective multimedia presentations.*

Using simulations

12. Nearly all Key Stage 4 pupils working in food technology or electronics confidently use specific ICT simulation software to model their design ideas, and

increasingly Key Stage 3 pupils do so too. Pupils try out their design ideas and see the implications of their decisions before any making takes place. Newer software for food technology, which, for example, enables pupils to understand the effects of changing the proportion of ingredients, is only just becoming available. This promises to enhance pupils' capability to model their ideas, improve their understanding, and reduce product development time. Once introduced to these programs, teachers nearly always adopt them enthusiastically and generally use them well.

Using ICT to control systems

13. The use of ICT to control systems is unique to design and technology, but few pupils use ICT for control purposes in Key Stage 3 beyond completing basic illustrative design assignments, often using only construction kits. The potential of downloading control instructions to a programmable chip – PIC technology – although still rare, is growing rapidly in work with Key Stage 4 and post-16 pupils. The concepts of control – feedback, lag, inertia, stability, and oscillation – are critical to a genuine understanding of technology. So far, however, there is no suitable 'school-level' software available that helps pupils to acquire this knowledge and they do not understand these concepts sufficiently, or develop a wider appreciation of the possibilities of remote and automatic intervention in systems – a basic element of technology.

Using ICT as a teaching tool

14. Where teachers have ready access to a laptop of their own and a data projector, they rapidly develop good presentations for their classes, although a dusty environment is often a problem in workshops. Teachers find the inclusion of more visual material is easy and this helps them to include industrial illustrative material. This, and such techniques as animation, improves their explanation of new topics. Pupils find this form of presentation motivating.

Using integrated learning systems

15. The use of integrated learning systems is a recent development in design and technology. These systems usually consist of an expensive, extensive and mainly prescribed range of modules of work from which teachers select those that they consider will be most appropriate for pupils to work through. Pupils follow the detailed instructions, carrying out a range of tasks and assignments, usually with interest and sometimes with considerable excitement. There is frequent testing of knowledge through multi-choice questions. Assessment and record-keeping are managed by these systems which provide easy monitoring of pupils' attainment by the teacher. They are not very flexible once set up and are expensive in both funding and space. There is insufficient inspection evidence so far to judge accurately their effectiveness. These systems tend to cater for pupils' knowledge and understanding, but not their ability to apply this knowledge.

Implementation in schools

Management

16. A school's senior management team, working with the head of ICT, is usually responsible for the policy and practice in the school. The priority is usually for the installation of a school-wide network, frequently with extensive computer suites. The use of these facilities to support teaching and learning in the subjects of the curriculum is left to heads of each department, or ICT co-ordinators in each subject area. Tensions sometimes occur as design and technology staff often need easy, short-term but quick access to groups of 'on-line' computers rather than whole-lesson access in a computer suite. Although some schools still do not have a cross-curriculum team of staff to plan and advise on ICT use, most do. The effectiveness of this group is a key factor in maximising the Effect of ICT in the school.

17. Similarly, thoughtful departmental management is crucial to the development of ICT in design and technology, particularly in ensuring that each member of staff is competent in using applications specific to their own teaching programme: in using strengths and remedying weaknesses. In about half of design and technology departments this attention to staff competence is effective, but only one fifth formally monitor and evaluate ICT work in their department.

Staff development

18. The most successful staff development has been made where design and technology departments have been able to supplement NOF-funded training with good in-house support from subject specialists. Most design and technology teachers found that the general context-free NOF-funded training, considering mainly basic applications software and generic pedagogy, did not meet their needs. Many lost motivation and did not complete the training even when the school 'relaunched' the programme in an effort to re-interest teachers. There is a considerable difference in the completion rate of the different training providers, but the chief factor in success is the leadership of the ICT co-ordinator and the design and technology head of department.

> *Although the NOF-funded training was generally inadequate, with very little subject-specific content, some previously inexperienced staff benefited from the introduction to basic applications software. However, the most significant feature was the effective way in which this introduction was supplemented by careful, individually targeted in-house INSET. This provided a basis for subsequent, more subject-specific and specialist, INSET, mainly from equipment manufacturers. The mutual support among specialist design and technology teachers was excellent. It enabled formerly inexperienced staff to meet the school's carefully planned design and technology curriculum that included appropriate elements of ICT use in most design and technology projects. It also meant they could take design and technology classes in computer suites to cover design simulations, use Internet research in design tasks, e-mail manufacturers and suppliers for information, and use specialist graphics software.*

19. Good teaching and learning are often associated with the provision in the school of a capable technician. Technicians often provide good value for money, integrating older equipment into more modern networks and getting the most out of limited computer systems. In design and technology it is essential that non-teaching staff are able to fulfil the maintenance and material preparation roles, freeing the teachers to concentrate on their planning, preparation and teaching. In the best

circumstances, the technician supports the teachers in introducing new equipment and activities to design and technology classes providing valuable one-to-one support to pupils and fault-finding when equipment does not function as expected. This is particularly important as additional teachers begin to use such equipment when the 'ICT lead teacher' is not able to work with them.

Resources and accommodation

20. The availability of good ICT resources in design and technology is usually the result of the use of a variety of funding streams, including NGfL. Successful use of these resources depends on their purchase being complemented by effective planning:

> *The SMT of a newly established technology college used the additional specialist school funding, together with NGfL resources, to enhance pupils' access to powerful computers with broadband connection to the Internet and a wide range of CADCAM equipment within the design and technology department. The staff's pre-purchase planning was thorough and the associated training of technicians was included alongside teaching staff. This ensured equipment was always available for use and meant as many adults as possible could support the pupils in the specialist use of ICT in design and technology.*

21. Easy access for teachers to a computer and telematics is important. Those who were involved in the 'laptop-for-teachers' scheme made rapid progress in developing ICT capability. In a third of schools, limited resources seriously constrain the work in ICT within design and technology. Sometimes networks are new but do not function properly because of design weaknesses or inadequate commissioning, or computer-controlled machines do not function as predicted and minor problems bring lessons or projects to a juddering stop. If teachers are novices in using this equipment, even though they may be experienced in the use of earlier ICT activities, they quickly lose confidence and in future choose not to attempt new uses of ICT.

22. There is no evidence of NGfL funding being used for design and technology-specific improvements, but there is urgent need for more CADCAM equipment. Data projectors are now specifically itemised in DfES guidance, and it would be a great advantage if CADCAM equipment were similarly designated, with schools buying fewer computers but more peripherals. design and technology capitation has not kept pace with the increased need for specialist consumable materials. Lack of access to specialist advice has led to unwise purchasing decisions in a few cases. In a large minority of schools the design and technology department is the repository of older computer systems from elsewhere in the school. Sometimes this has worked well, increasing the number of systems available to pupils for design and technology work. However, work with graphics demands the fastest machines available and CAD/simulation work is often too slow on these machines. Similarly, some networks function too slowly for such applications.

23. Many schools find difficulty in siting computer systems in workshop areas because of both dust and inadequate space. One school found that the use of laptop machines with radio connection to the network worked well. Space was saved when they were not in use and the closing lid reduced the ingress of dust. The DfES/DATA CADCAM initiative wisely provided only laptop machines.

24. Most design and technology departments, however, work hard to identify and convert a suitably clean dedicated space, often on a 'self-help' basis, to

accommodate computer systems and associated resources. These work particularly well when the space is part of the general departmental resource base. Access for whole classes to computer systems for such work as control activity remains a particular problem, especially when specialist peripherals are needed. The pressure on networked computer rooms is high and access for subject work is often difficult to plan. Most design and technology departments have to make extensive use of their ICT facilities in lunchtimes and after school session. Often these have to be programmed to cope with the demand.