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

Secondary science

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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 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

- The application of ICT in science lessons is generally making a good contribution to pupils' achievement.
- The competence of science teachers to use ICT in their professional role outside the classroom and in the classroom to promote pupils' learning is good or better in over four fifths of schools.
- Too often, teaching that uses ICT is not fully effective because teachers are insufficiently aware of pupils' ICT capability.
- The leadership shown by senior management is a key factor in raising standards through the application of ICT.
- The use of ICT has had a positive impact on the management and analysis of pupils' achievement in science.
- Teachers in many science departments are in a good position to report on aspects of ICT capability, such as data logging, but very few do so.
- In around one in five schools visited, New Opportunities Fund (NOF) training did not adequately address the identified needs of teachers, many of whom considered the training too generic. In half the schools the training was good, particularly where the school used subject specialist trainers.

The impact of the initiatives

Teaching and learning in science

Overall in this survey, the quality of teaching which used ICT in science was good or better in around two thirds of lessons. These proportions are in line with those found in section 10 inspections during the year 2002–03. In this survey no lessons were seen where teaching or learning using ICT was unsatisfactory.

Teachers are enthusiastic and show good levels of skill in using ICT in teaching science. No unsatisfactory use of ICT was seen in the survey and the proportion of lessons in which very effective use was seen was around one in ten. In over 80% of lessons, teachers' effectiveness in the use of ICT was good.

There is a good match between the lesson objectives and the ICT employed, and it is rarely used in merely cosmetic ways. In the main, the ICT is appropriately demanding and adds to the richness of learning in science in ways that only ICT can – for example by engaging pupils in activities that are beyond first-hand experience and manipulating variables at a rate and of a variety not readily attainable in practical activity. The following example is from a Year 10 lesson:

> *The objective was to establish how salts of alkali metals could be made in the laboratory. A starter activity used the interactive whiteboard and involved individuals fully in an exercise interpreting PH values, building on previous work. This was effective in engaging pupils and preparing them for working on reactions involving neutralisation. The teacher gave a clear digitally projected presentation of neutralisation with information being added as pupils responded with enthusiasm to well-directed questions. The teacher gave a very clear description of practical work, with good reminders on safety matters. The teacher's instructions for titration were given orally but supported by digitally projected text.*
>
> *Pupils proceeded very efficiently with due regard to safety and accuracy. This was a very crisply paced practical activity, with pupils monitored well by the teacher to check their understanding. Pupils' responses were good, showing secure understanding of procedures. Pupils raised their own questions with the teacher as work continued. A class question and answer session took place to secure the new knowledge and understanding and outcomes were displayed on the interactive whiteboard. The teacher used the whiteboard to record the ionic nature of the reactions observed and discussed them. The teacher then worked with the class using dedicated software to produce balanced symbolic equations. Pupils engaged well in this activity and discussions on energy changes and crystallisation followed. Pupils showed themselves to be responsible and self-disciplined in practical work and class discussion. The teacher led an effective plenary, using an ICT-based titration demonstration that showed heat of neutralisation.*

Some of the best teaching combines high-quality science, good use of ICT and methodology taken from the Key Stage 3 Strategy, as in this Year 7 example:

> *The teacher explained the lesson objectives and then moved to a whiteboard session on fuels and products of burning which involved the pupils. The teacher checking carefully whether the pupils understood, identifying products of burning sulphur in air. A very effective demonstration of the origin of acid rain used apparatus to generate nitrogen dioxide, by heating water to produce water vapour, mixing and condensing to form acid rain. This turned a neutral solution acidic, which was identified using universal indicator liquid. Pupils were very engaged and fully motivated to join in and contribute answers and ideas. There was a very good plenary session, using questions and answers and published articles to check pupils' understanding of web-*

based environmental reports and to assess the learning from the lesson. Pupils' views were effectively captured on the interactive whiteboard.

Most teachers demonstrate at least satisfactory expertise in the use of ICT outside the classroom: their competence is good in half the schools and very good in over one third. Increasingly teachers use administrative software and systems for recording assessment data, generating reports, producing pupil profiles and other documentation required in the management of the subject. Teachers are generally very positive about the impact of ICT on their management and analysis of pupils' achievement. The best practice seen involved the use of a database into which all science staff were required to enter data for their own teaching groups. The entry of data was done online with a clearly set out sequence of data entry points and meetings to inform discussion on standards and the progress of individuals and groups. These data were accessible to all teachers. Some of the procedures and benefits for teachers in one school are reported in this example:

ICT had significantly improved the management of assessment data and the use of such data in setting targets for pupils. This year, two members of staff had been appointed to monitor pupils' performance – one for Key Stage 4 and one for Key Stage 3. For example, the Key Stage 4 co-ordinator had set up a spreadsheet to tally pupils and subjects and give an at-a-glance view of whether students were working very well, satisfactorily or were performing below expectations. This information, collated centrally, was then given out to subject teachers and pastoral tutors. The subject teacher evaluated the progress and achievement being made by pupils and it resulted in a colour co-ordinated spreadsheet where underachievement was identified as red, on target as orange and good performance shown as green. This had a positive effect on pastoral staff, informing their discussions with pupils and subject staff, and in addressing individual learning needs in science. It has raised many of teachers' questions about the effectiveness of their teaching, about the differential performance of pupils in subject areas and any problems that might be at the root of that differential performance. All staff had access to the spreadsheet on the intranet and it was discussed formally at departmental meetings.

In around one third of schools, staff have used ICT evidence in electronic form, often onscreen, to assess pupils' work. However, in many the use of evidence in electronic form is not well developed. Although the outcomes of the assessment are most often recorded electronically, very few examples were seen where an electronic folio of work was being kept by staff. Students are rarely required to keep such records and very few examples of work are being submitted and assessed electronically. In most schools visited, only hard copies of computer-based activities are used as part of the work that is assessed by teachers:

In one school, judged to be at least good in most aspects of ICT application, many pupils chose to carry out self-assessment by using the test yourself facilities on the subject site. Science and technology have such materials but they are not consistently available across the curriculum. At Key Stage 4, some of the project work undertaken by science students was in electronic form, such as multimedia presentations on renewable energy. No tracking of the development of a piece of

work by a teacher was seen within science except where it was used as part of the folio for a pupil's ICT course work.

There are very few schools where science staff systematically contribute assessments to the school's evaluation of pupils' ICT capabilities, for example taking on the responsibility for assessing data-logging capability of students. There are some examples of students collecting items from their work in science to exemplify their ICT learning for assessment purposes. There are many lost opportunities to combine the co-ordination of ICT teaching and learning across the curriculum with recording and statutory reporting of pupils' ICT capabilities:

In one school visited, science staff assessed the levels of ICT capability for each pupil and sent the data to the ICT co-ordinator. The level assessment was linked directly to specific aspects of ICT which were allocated to the science department as part of a whole-school co-ordinated approach.

ICT technicians were present for some of the time in less than half the lessons observed. In around one third of the lessons where technicians were seen their use was better than satisfactory. In the best examples technicians not only attend to immediate hardware and software needs but they also make contributions to pupils' knowledge and skills by intervening and by acting as a reference point for them. Technicians deployed in this active and broader way express enhanced professional satisfaction from their role.

Learning assistants, too, are generally well used and this is made possible by effective planning that has been shared by the teacher with the learning support staff, as in this example of a special educational needs (SEN) group:

Pupils from Year 9 worked individually to research, via prepared web-addresses, websites relating to the early space programmes of the superpowers. Throughout the lesson, with skilful but unobtrusive support from the class teacher and SEN learning assistant, pupils made very good progress towards the objective of a final summary sheet on their personal section of the project. All the pupils worked hard, staying on task, and enjoying excellent relationships with the teacher, support staff and each other. The plenary involved all pupils in sharing their aspect of the timeline, and sticking it up on the wall. Although some pupils were finding the précis of large volumes of text quite difficult, most were competently using ICT to select material and assemble it on a presentation page. The classroom learning assistant was used as much as the class teacher as a reference point for pupils. The lesson ended with a class 'meal' of space food, representing American and Russian foods, which pupils had prepared with the guidance of the support assistant.

Standards and achievement in science

The application of ICT is making a good contribution to pupils' achievement in the majority of schools, as in this example:

In Year 7 a pupil recorded on a laptop, and displayed on the whiteboard, the outcomes of pupils' work on sorting energy resources into renewable and non-renewable groups, using a bank of information cards and an organisational grid. This

rapidly made the class data available to all the pupils, so promoted a good pace. An effective class discussion of answers from pupils sorted out anomalies identified on the whiteboard and pupils' understanding developed quickly. Good discussion involved effective links to the geographical knowledge and understanding of pupils, an element of the scheme of work jointly planned with geography staff. There was careful development of accurate vocabulary, for example 'biomass'.

The main contributions of ICT to pupils' achievement in science are seen in the retrieval and exchange of ICT-based information, which pupils understand, evaluate and summarise. In most schools this contribution was good or better. In around two thirds of schools pupils make good use of ICT-based data for analysis, investigation of patterns and the drawing of conclusions:

Pupils' use of spreadsheets included the collation of results from quadrant surveys in Year 8, the law of constant composition in chemistry and handling data on variation in biology in Year 10. The use of particular software enabled investigations of projectile motion in Year 7, the analysis of diet in Year 8 and the effect of different coloured light on objects in Year 9. There were opportunities to use data-logging throughout Key Stages 3 and 4.

In the majority of schools, too, pupils produce ICT products that are good or better. These products are usually for presentation or display purposes, promoting science knowledge and understanding in ways that ICT enhances. In no school was the standard of these ICT products less than satisfactory overall:

Particularly in Key Stage 4, students had done some very good work in generating multimedia presentations on issues they had been researching for coursework assessment. Many of these had used digital images and desktop publishing effectively. Students had referred to web pages and had included motion and sound in some of their presentations.

In all schools visited the schemes of work in science departments referred satisfactorily to National Curriculum ICT requirements. In the majority, these references were of good quality with clear links made between particular learning objectives and available ICT resources. In one school visited there was very clear mapping of ICT opportunities built in systematically to the science schemes of work. The way the department worked encouraged these ICT references to become the entitlement for pupils and evidence from work scrutiny indicates that these opportunities were indeed being taken. The head of department included coverage of ICT as part of the departmental monitoring activity to ensure pupils had access to their entitlement.

Implementation in schools

Leadership and management

The leadership shown by senior management and heads of department is a key factor in the successful use of ICT in science. The best practice seen in science lessons is in schools where the climate for ICT development, use and support is strongly positive. In schools that are furthest forward, the development plan sets a clear framework for planning and for the evaluation of effectiveness of ICT use. Without this the use of ICT is inconsistent and its contribution to quality is not readily measurable.

The increased use of ICT has had a positive effect on the quality of science curriculum provision, which in most schools is good. In this example, enhanced provision had additional benefits:

> *In science, ICT had provided an important platform to enhance pupils' motivation. ICT provision was part of the faculty's philosophy of accelerating progress through the science curriculum so as to give time in Key Stage 4 for additional extension activities including trips and visits. This strategy contributed to the good added value in pupils' performance in science. The City Learning Centre associated with the school brought welcome additional specialist hardware that the skilled science department had been quick to exploit, including digital imaging and video facilities. The department is also using laptops with pupils to enrich traditional learning experiences.*

In all the schools visited, the senior management team planned for ICT work to be monitored and evaluated by designated staff. This was seen to have a positive impact on the quality of work in science. Where evaluation was carried out well there was a corresponding clarity to teachers' thinking about the purposes and value of ICT in the classroom.

However, in too many schools the contribution of science departments to teaching and learning in ICT is not well co-ordinated, and science teachers are insufficiently aware of pupils' ICT capability and experiences across the curriculum. This makes it very difficult to plan for progression across the curriculum.

Staff development

The extent to which NOF training addressed science teachers' personal and pedagogical needs in ICT skills was very varied. In most cases the audit of skills that preceded training was used well to identify individual needs and pedagogical needs. However, many teachers commented on their disappointment with NOF-funded training and felt it did not match their expectations. Particular disappointment was associated with the generic nature of the training experienced compared with the individual treatment they thought the needs analysis had indicated. In around one quarter of schools, NOF training had not contributed significantly to the quality of teaching and hence to pupils' achievement; in just over one third of schools the training was credited with having a good or better impact. The schools which had used subject specialist

providers for the training of science staff reported more successful outcomes. Some acknowledged the benefits of training associated with other initiatives. For example, in one school the course allowed for individual tutoring that developed teachers' skills further:

> *Staff were able to explore a range of software and a range of skills including spreadsheets, databases, whiteboards and multimedia presentations. As a result, staff expressed high levels of satisfaction and confidence to continue to develop their use of ICT in science lessons. The senior management team and teachers interviewed judged that the Key Stage 3 Strategy work on ICT has had a significant impact. The impact has been on raising the awareness of staff as to the need to use ICT themselves and to develop ICT capabilities in their pupils. The 'Laptop for Teachers' scheme is seen as beneficial but not extensive enough in that it is beyond the means of the school to provide laptops for all members of staff. There had been a big build-up of expectation in the school before the NOF training. In reaction to the NOF training, staff from most curriculum areas expressed disappointment, though the science department was generally enthusiastic about the training it had received from science-specific trainers.*

In one school where NOF-funded training had had a positive impact, discussions with about half the science teaching staff revealed an increased enthusiasm for teaching using ICT and a consequent and significant improvement in pupils' attitude to learning:

> *Most science staff were not yet at the stage of developing much of their own teaching material but were able to use effectively what had been done by leading members of the department. The head of science, in monitoring science lessons, had seen how pupils were now being presented with material in ways which suited their learning needs, for example with a good emphasis on simulations and a focus on what was essential to extend learning experiences. This monitoring information was being linked to future training for staff.*

Resources and accommodation

In all schools surveyed, pupils' access to suitable accommodation was at least satisfactory. In around half the schools accommodation was at least good and in just over one in ten schools was very good. In the best schools there was a pupil–computer ratio which was better than 4:1. Computers were available in subject suites, either in separate rooms or in designated bays with more open access within the curriculum area. Accessibility and reliability are two factors most often cited by staff as contributing to the quality of ICT provision.

Many departments have ensured that pupils are in a good position to use the available facilities, as in this example:

> *Pupils were issued with CD-ROMs in Key Stage 3 and Key Stage 4. These CD-ROMs had been generated by the science department and contained some curriculum information, revision materials and tests to support pupils in their learning in and out of school. Pupils could borrow software and there was a good range of materials to support their learning. Pupils had access to the internet through a well-managed*

system which excluded them from inappropriate sites. To further support pupils' learning they had access to hardware and software during lunchtime and after school for 1 hour 30 minutes. There was always a member of staff present in the ICT room to supervise pupils' activity. Teachers or learning support assistants were available for advice and information at these access times. A survey had shown that only 34% of pupils had computers at home or accessible to them at their parents' work place. This meant that only 21% had full access at home. In response to this finding, the school was seeking ways to give pupils the best access possible to good quality ICT.

As resources have improved and more interactive software has become available, the willingness of staff to incorporate ICT into their teaching has increased. Well-maintained, robust systems and a well-planned curriculum have encouraged staff to use ICT with their pupils. Continued development of resources is needed to provide software and hardware that allow a diversity and richness of learning experiences unattainable through traditional science teaching.