Integrating ICT in the Teaching of Science in Secondary Schools

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Abstract

A national programme to train all existing teachers in the use of ICT has given valuable insights into a range of factors concerning the implementation, integration and effect of using ICT in science teaching. In particular, the pedagogical role of the teacher emerges undiminished by the technology, but retains vital functions such as forging links between the products of web searching and other class activities before, during and after the computer-based lesson. Reports of successful lessons with ICT not only contained examples of good pedagogical practice, such as the clear definition of lesson objectives and structured tasks, but also frequently implied that teachers had intentionally or instinctively adapted their traditional skills of managing, monitoring and facilitating pupils’ learning.

Introduction

England is currently engaged in a nation-wide programme of teacher development in the integration and use of Information and Communication Technology (ICT) in subject teaching across the curriculum. The study reported here focuses on a development programme for science teachers in secondary schools provided by The Science Consortium (SC), one of about forty training organisations participating in the national scheme. By the completion of the scheme in March 2003 teachers in science departments in about 1000 schools will have participated in the SC programme. Mainly delivered through distance learning, the SC programme encourages teachers to engage in an iterative cycle of reflective teaching in their own classrooms based on a pre-prepared framework of lessons. The course has six modules, each one looking at a different application or way of using ICT within science. For each module the candidates are required to teach one of their normal science classes using ICT, and send in a written evaluation of it. All the necessary materials are provided, including software, lesson plans and worksheets, and within a particular module a wide range of topic areas and levels of presentation are available to suit the requirements of a range of pupil groups. Each science teacher is individually registered and has on-line contact with a SC tutor who gives feedback on their evaluations.

Theoretical Background

Many benefits of using ICT in education have been claimed in the past and many studies have pointed to the important influence of the teacher in realising such benefits. Dwyer, Ringstaff and Sandholz [1] found that when teachers teach with technology they tend to expect more of their students, teaching to a higher level; they believe they can be more student centred, meeting the needs of individuals; and they are more open to different perspectives on problems. Rogers and Wild [2] identified a richer exploitation of data-logging methods in classes where the teacher encouraged investigative approaches and pupil autonomy. Lesgold [3] has warned against oversimplifying the issues involved in integrating new technology in a wide range of schools. In his view the technology often acts as a facilitator or amplifier of various educational practices, rather than a direct cause of change.

Large scale studies investigating the development of ICT in normal classroom teaching settings are few in number, thus the SC training programme provides a unique opportunity to examine a range of factors concerning the implementation, integration and effect of using ICT in science teaching. Several strands of investigation have been pursued so far and this paper reports on one strand, a critical examination of the perceived benefits of using ICT within science teaching and learning.

Procedure

The teachers’ evaluations of each of their lessons taught with ICT were the principal source of data. The evaluations were obtained from the teachers’ on-line submissions using a standard pro forma supplied by the SC. This elicited teachers’ comments on lesson organisation, planning and management issues, perceptions of the effect of ICT on the teacher’s role, pupils’ achievements and learning outcomes for the teacher. A preliminary analysis of the data from a limited number of evaluations was carried out independently by each researcher, using the Nvivo qualitative analysis tool. This process involved classifying teachers’ responses with a pilot coding system. The results from each researcher were compared and discussed and the exercise repeated to determine the extent, limitations and validity of the data. A revised coding system was then agreed for examining a larger sample of evaluations from 63 teachers in 10 school departments. Schools were chosen to
represent a spread of different types and different geographical areas. Teachers’ perceptions of the advantages and limitations of using ICT in the teaching of science, and in pupils’ learning were taken from the appropriate coding throughout the data set.

Results

The benefits of using ICT were evident both within science teaching, from the point of view of the teacher in presenting and running the class, and for the pupils’ learning, as assessed by the teachers. There were also some drawbacks mentioned within the teaching particularly, related to the preparation required, but those anticipated by the teachers to do with pupil response to learning with ICT, such as wasting time and diverging from the educational purpose were generally not forthcoming. One of the teaching benefits recognised by many teachers was that whilst using ICT they had more time to give attention to the lower achieving individuals. Teachers liked the flexibility of software which gave a variety of opportunities for pupil involvement, often helping to make abstract concepts real through the imaginative use of animated interactive graphics. It was recognised that, as a substitute for laboratory ‘hands-on’ practical work, the advantages of low cost, convenience and guaranteed safety were slightly offset by the lack of opportunity to develop pupils’ awareness of safety. Many teachers regarded simulations as amplifiers of real laboratory exercises rather than as substitutes for them. Teacher reports also gave many insights into aspects of lesson planning which helped to exploit the potential benefits of the software. Many underlined the importance of identifying clear lesson objectives and linking the activity where possible with conventional tasks. An investigative approach to task design, in which pupils were encouraged to make predictions and then use the software to test them, was often cited as a successful teaching strategy.

Activities involving information searches on CD ROMs or on the Internet required careful planning in order to achieve the intended learning objectives. The majority of teachers reported the importance of tightly defined tasks with clear deadlines. The theme of clear definition extended to the selection of web sites which needed to be scrutinised in advance for the level of language use and information content. Teachers recognised the benefits of giving pupils responsibility, but emphasised the concurrent need to develop their critical skills in relation to the integrity of sources and validity of content. Also, teachers realised that their pedagogical role, far from being diminished by the technology, retained vital functions such as forging links between the products of web searching and other class activities before, during and after the computer-based lesson. It was evident that the reports of successful lessons frequently implied that teachers had intentionally or instinctively adapted their traditional skills of managing, monitoring and facilitating pupils’ learning. The ‘time bonus’ of the technology was often profitably employed in interactions with pupils.

Modelling activities using software rich in animated graphics were reported to be very successful in engaging pupils’ commitment, building confidence in working independently and at their own pace. Many teachers were enthusiastic about modelling as an amplifier of understanding. The aspect of pupils being in control of the software-based scenario was considered to be an important encouragement to their thinking. Again, teachers sought to encourage discussion and frequently reported that clear understanding was achieved. However, teachers recognised that adequate preparation was needed for pupils to take control effectively and this not only entailed operational training with the software, but often involved making explicit links between the model and reality. The complimentary nature of modelling tools was reflected in the frequently reported ambition of teachers to integrate modelling with other ICT applications.

Conclusions and further study

The results amplify the findings of previous research which highlight the contribution of the teacher’s role in determining the effectiveness of ICT in science lessons. Teachers’ skills in using ICT, and good quality equipment, are both helpful for a science department to integrate ICT within their science classes. However this study suggests that the area which is most in need of development is that of appropriate pedagogy and teachers’ understanding of the philosophy behind the different ICT applications. This understanding can come about when teachers have successful lessons using ICT, sometimes by stepping outside their preferred teaching approaches. Such successful teaching episodes depend on thorough preparations beforehand, linking the ICT to on-going teaching and learning.