MANAGEMENT AND THE USE OF ICT IN SUBJECT TEACHING

Integration for Learning

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Abstract: Improving teaching and learning in the classroom is the key issue facing educational leaders in UK secondary schools and information and communication technology (ICT) is being employed in a range of ways to support this endeavour. However, it is in everyday classrooms that the benefits of ICT for teaching and learning are most immediately felt and this is where the leadership vision will be secured. Many teachers feel the pressure to use ICT in their lessons but they are often faced with the problem of where and how it fits within existing teaching frameworks or understanding how it enriches pupils' classroom experiences. This paper argues that problems of ICT integration have a managerial dimension that relates to the planning and implementation of lessons. Drawing on experiences in science education, it presents frameworks that offer a means of analysing the beneficial features of ICT in relation to teaching and learning goals and identifying the skills of classroom application required to achieve these. It is suggested that many of these application skills find relevance in non-ICT activities that may be familiar and that teachers already possess professional skills that have relevance in ICT settings.

Key words: Integration, skills, teaching, learning

1. INTRODUCTION

Improving teaching and learning in the classroom is the key issue facing educational leaders in UK schools. The use of information and communication technology (ICT) in secondary school education is a focus of widespread interest. Developers of software and users of ICT often extol its virtues and some governments have invested high hopes (and significant

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financial resources) in the anticipation that new technologies will deliver improvements in education. Yet, the use of ICT in classrooms is problematic and questions are beginning to be asked about exactly what ICT can deliver for education and how any benefits can be secured. This paper argues that integration of new technology into classroom practice is essentially a problem of management. It draws on experiences from science education in the England to tease out generic issues requiring a management focus for teachers employing ICT in subject teaching.

2. ICT AND ISSUES OF CHANGE

The use of information and communication technology in education is characterised by change. To take some aspects of the UK experience by way of example, the early appearance of microcomputers in secondary schools in the 1980s allowed teachers to begin to harness the calculating power of these machines to serve teaching purposes. This was especially the case in science education where some teachers had the specialist technical knowledge (and interest) to develop the potential application of new technology in teaching. For example, by linking the computer directly to apparatus for the purposes of making experimental measurements it became possible to collect data for graphical display in software.

Rapid technical developments in the speed, memory and display properties of computer hardware together with concomitant developments in software (much of it tailor-made for the education market) now provide teachers with ICT resources of considerable sophistication and educational potential. However, in England, as elsewhere, developments in ICT have taken place in parallel with rafts of other educational reforms and initiatives and this has sometimes created a climate that has overshadowed teachers' use of ICT. This appears to have been true even where initiatives have been in tune with the educational potential of new technology (Newton and Rogers 2001).

In society as in schools, burgeoning technology has understandably resulted in the technology itself becoming a focus of strong interest. It is perhaps inevitable that the acquisition of the latest technology in schools has trailed that available in the High Street and in many homes. This may have some unforeseen effects in terms of pupils' motivational responses to working in school with older computer technology than they may have in their bedrooms (Keele University / National Council For Educational Technology (NCET) 1997); nevertheless it is a reality in many schools and likely to remain so in the foreseeable future.

The capacity of English schools to accommodate developments in new technology has been constrained by uneven levels of resource and by a lack of ICT confidence in a significant proportion of schoolteachers. The government has sought to address this deficit in skills through pre-service (Department for Education and Employment (DfEE) 1998) and in-service training initiatives (Teacher Training Agency (TTA) 1998). In the context of science teaching, barriers to ICT use have been described in three broad areas: Shortages in computers and related hardware; lack of teacher expertise and inclination (for some) to use computers coupled with a lack of access to machines to address these issues; and finally the lack of clarity of teaching purpose when faced with a wide range of possible options and generic software (Tebbutt 2000). In addition to these factors, Tebbutt raises the need to consider issues pertaining to teachers' workload and pupil characteristics, which might also influence adoption of ICT approaches in favour of non-ICT alternatives. Thus the development and integration of ICT for teaching purposes has proved to be more problematic than technophiles and politicians may have expected or wished. Uneven distribution of ICT resources, deficits in the necessary ICT skills and a lack of pedagogy for teaching subjects with ICT has each contributed to the complexity of integrating new technology into subject teaching.

3. INTEGRATION OF ICT - A MANAGEMENT PERSPECTIVE

The use of ICT in subject teaching involves the integration into lessons of an innovative teaching tool. It is useful therefore to consider how scholarship on the management of educational innovation can illuminate integration of ICT into classroom practice. An authoritative source of such scholarship can be found in the work of Elliot Rogers (Rogers 1995). Rogers suggests that to better understand the implementation of an innovation, attention needs to be paid to the differences between the characteristics of people adopting innovations in addition to the features of the innovation itself. Moreover, scholars of innovation diffusion have seen an individual's perceptions of the attributes of an innovation as useful predictors of the rate of its adoption (Rogers 1995).

With particular reference to educational settings, Michael Fullan has described 'needs identification', 'goal clarity', 'complexity' and 'practicality' as key factors that affect successful implementation of an innovation (Fullan 1991). To develop the discussion further, needs identification raises questions about the relative importance of the innovation and what priority it should be given amongst other initiatives. In England

and Wales, the need to use ICT in teaching is driven by the demands of the National Curriculum. But in science education, as in other disciplines, the attributes of the technology itself and the benefits it brings to teaching might lead teachers to choose to use ICT for its own sake. Goal clarity influences the means by which goals are achieved. Policies and curriculum programs are frequently stated in general terms, but a lack of clarity about specific goals and the precise means of achieving them are major problems in the successful implementation of educational innovations (Fullan 1991: 70). Complexity concerns the degree of difficulty in using the innovation itself, the shifts in beliefs and values associated with using it; and the need to acquire new strategies, resources and understandings to support its use. Quality and practicality concerns the suitability of the innovation for its purpose and that the practical changes which the innovation brings fit well with teachers' situations and requirements. The innovation needs to be practical in the sense that it is achievable. Teachers need to be offered 'how to do it' advice, so that they can learn through first hand experience of the innovation. This will help to enhance professional ownership of the innovation through development of personal meaning and an appreciation of its usefulness (Fullan 1991). An example of the application of these theoretical principles to the use of microcomputer-based laboratories (MBL) in science teaching has been reported elsewhere (Newton 1999).

What emerges from the above discussion is that whatever the policies or requirements, ultimately, successful integration of ICT into teaching is dependent on the attitudes, understanding and actions of individual teachers towards teaching with new technology.

4. INTEGRATION AND THE NEED TO SHIFT FOCUS FROM TECHNOLOGY TO PEDAGOGY

It has been argued that too strong a focus on technology at the expense of pedagogy has been a barrier to integration of ICT into curricula because of a failure to consider the processes of ICT use (Earle 2001). Indeed the need to focus on the relationships between aspects of computer technology and other classroom events is an issue that has arisen from studies over some years. For example, the ImpacT study identified the importance of understanding aspects of teachers' knowledge in using ICT (Watson 1993). More recently, and at a higher level of technological sophistication, the UK evaluation of so-called Integrated Learning Systems (ILS) suggested that the benefits to pupils of these instructional systems depended at least in part on their use in relation to other, non-computer, activity (Woods 1998). Indeed, when reading reports of research involving classroom use of ICT one is often left

with questions of the extent to which any benefits claimed could be directly attributed to new technology, or whether other factors could have a bearing on outcomes. The problem that this issue raises for researchers evaluating ICT in learning environments concerns the effects on outcomes of the context of ICT use and this matter has recently been examined in the literature (Tolmie 2001). Tolmie argues that evaluations of ICT need to acknowledge contexts of use and the interplay between the components of the context, which together constitute the ICT implementation 'event'. This approach is reminiscent of the situated evaluation of software (Squires and McDougall 1996) but, importantly, extends it to include consideration of how mode of use may effect integration of ICT in classrooms.

Consideration of factors such as mode of ICT use, the relationships between ICT and non-ICT classroom activities, the context of ICT use etc. shifts the integration issue towards the management of resources and curriculum. In other words, the managerial functions of teachers employing ICT to achieve particular teaching and learning purposes require closer scrutiny than they have previously received.

5. INTEGRATING ICT INTO SECONDARY SCIENCE TEACHING

A major issue facing teachers is to be able to define what it means to integrate ICT into teaching. What is it that needs to be done in teachers' own working contexts to be able to integrate ICT? In other words, how can the need for ICT integration be operationalised into specific strategies and actions for teachers? The rest of this paper draws on experience of using ICT in science teaching and presents frameworks that are useful to support the management of ICT at the level of the classroom. The argument is grounded in the view that the managerial role of science teachers embraces the functions of preparation and planning of suitable activities using ICT as well as their execution in the classroom; and that these functions are part of the integration process.

5.1 Lessons from teaching science with ICT

As suggested above it is possible that those wishing to integrate ICT into teaching start in the wrong place; that is thinking first about the technology rather than the needs of the science curriculum. Computers need to be used in the service of teachers and, for individual lessons, this means thinking clearly about the curriculum objectives of the lesson and the knowledge,

skills and understanding needed by the pupils. These are the very aspects of the teacher's craft with which they are likely to be most familiar - they are specialists in the teaching of their subject.

Contemporary science teaching has been strongly influenced by constructivist teaching philosophy (Driver et al. 1994) and this puts the learner at the heart of the teaching-learning process. One consequence of this view is that at its best, science teaching should engage pupils in activities in a thinking way. Mental alertness and active participation are key elements of learning in this mode and this is widely accepted to underpin effective science teaching.

At face value, ICT lessons can offer many interactivity and high levels of learner-centred engagement with tasks. Everyday experience tells us that many students like ICT-based lessons but is this just because of the novelty effects (which may fade over time) or because it adds variety and is better than listening to the teacher? The argument presented here is that there are other, more subtle, benefits to science learners that accrue from using ICT to teach science. The introduction of ICT extends the range of contexts in which interactive teaching approaches can be developed and it is therefore necessary to be able to identify the value that the use of ICT can add in these contexts.

5.2 The added value of ICT

A necessary first step in planning any lesson is to have identified specific subject objectives for the learners, integration of ICT then becomes a question of deciding how the use of ICT can help secure these desired outcomes. Achieving this goal requires that teachers appreciate the ways that ICT can add value to pupils' experience. However, this is only possible once the desired lesson outcomes have been identified.

In science education, it has become helpful to think about the added value in two respects, first the intrinsic properties of ICT and second its potential benefits for users. This framework of 'properties and benefits' was first described in the context of MBL activities (Rogers and Wild 1996). For the purpose of the present discussion, the distinction between ICT properties and benefits requires further explanation. The intrinsic properties of ICT tools that can offer advantages such as time saving, the ability to handle large quantities of data, automated operations etc. provide a set of first level benefits. For example, the facility of automating calculation or graphing is both convenient and saves time that can be used by pupils for other purposes. However, whether any time saved can be used for learning benefits is dependent on the mode of use of software and this is in the hands of the teacher or pupil, it is not a feature of the software itself. This leads,

therefore, to a second set of benefits that can be seen as potential benefits that are not automatic but which derive from the mode of application of the ICT tool in the classroom. Here, it is decisions made by teachers and pupils concerning the mode of use that are critical to securing these additional benefits.

The label 'ICT' embraces a range of software with very different features, for example word processors, graphing software, communications software. It is clearly unhelpful to talk about the range of ICT types as if they were all identical and to suggest that a single model of integration will suit each type is equally unhelpful. The properties and benefits framework has proved to be a valuable aid to thinking about using ICT in science and it has recently been applied to other types of ICT and developed further to consider the types of skills required to exploit the useful aspects of software for teaching purposes (Newton and Rogers 2001). This approach enables the teacher to identify the beneficial features of a software tool in relation to its proposed context and purpose of use.

Understanding of ICT properties and their potential benefits leads to a consideration of skill requirements when teaching with ICT. Skills of an operational kind concern the functional aspects of software use and lead to the first level benefits derived from software properties. More subtly, application of ICT tools to particular science learning purposes requires additional skills and understanding that can provide added value depending on the mode of use and it is here that the contribution of ICT can be developed. It is these so-called application skills (Newton and Rogers 2001) that are proposed to be necessary to enable successful integration of ICT in science teaching and some examples of these skills from science education are presented in Table 1-1.

Table 1-1. Application skills for using ICT in science teaching

VISUAL AIDS e.g. CDROM	GRAPHING TOOLS
<ul style="list-style-type: none"> • Designing suitable tasks and worksheets, embodying a purpose (teacher skill) • Exploiting interactivity • Viewing with intent; looking for certain features • Reviewing images to seek further meaning • Making comparisons, thinking about links • Avoiding superficial interactivity or 'clickiness' 	<ul style="list-style-type: none"> • Observing the graph qualitatively • Reading values • Describing variables • Relating variables • Predicting • Mathematical modelling

6. MANAGING INTEGRATION: PLANNING AND ORCHESTRATING LESSONS USING ICT

At this point, it is necessary to review the preceding arguments, which have been concerned to define 'integration' of ICT by identifying strategies and actions requiring management at the level of the classroom.

6.1 Planning lessons

The fundamental issue underpinning integration of ICT is the identification of specific curricular requirements in terms of personal learning outcomes for pupils. These objectives drive the choice of planned teaching approach and selection of learning activities. Planning for teaching means thinking about the needs of learners and teaching for learning involves teachers in understanding the learning process and facilitating pupils in their construction of meaning from information and experience. These are fundamental generic teaching skills and they are equally pertinent in teaching situations involving ICT since they can drive critical the selection of ICT teaching tools.

If an ICT approach is selected, this should be done in the knowledge of the features of the ICT tool itself and the likely value added to the learning experience by its use. This requires teachers to have understanding of the properties of ICT tools and operational skills in their use. Crucially, it also requires teachers to have understanding of the potential benefits that can emerge from using the ICT tool in particular ways in the classroom. This knowledge can be viewed as 'application skill' and it embraces knowledge of what software can do and what it might contribute to the intended purposes. With this understanding, a particular software instrument can be selected because it possesses certain properties and offers particular benefits suited to that learning purpose. As teachers become more experienced in the use of particular pieces of software, so appreciation of the value it can add to learning activities grows. There is a real sense in which increasing familiarity with the use of ICT can foster the development of new activities. Over time, this can lead to insightful new uses for software, which in turn, leads teachers to develop new learning objectives. Rewards of this kind are won through a maturity of experience and reflection on using ICT in teaching

Clearly, novice users will require training in the operational skills required to use software, but once these skills are mastered, then the tool can be employed to serve a learning purpose. For teachers planning lessons to secure specified learning outcomes, task design is informed by knowledge of

the potential of ICT, scope of activities, value added by ICT and the skills and experience of the learners.

6.2 Orchestrating lessons - the teacher in action

Teaching is about many things including lesson planning and classroom management. Orchestrating lessons in action is a reflexive process, but at its best, it is underpinned by sound planning. Teachers have many roles in the classroom but in ICT context, the role as provider of knowledge is often reduced since this function is partly assumed by the computer. In contrast, teachers' roles of enabler, challenger, adviser and respondent to pupils can take on much greater importance and it is hard to see how even the most sophisticated software could replace the teachers' skills in interacting with pupils at this level.

Integrating ICT into teaching involves making links between ICT teaching episodes and other related activity. Often pupils' work at the computer alone or in small groups and this apparently 'self-contained' activity may lead teachers to be hesitant about engaging pupils in conversation about their work. However, carefully timed interventions can enable teachers to help pupils working in ICT activities. Interventions help pupils to learn to notice things by focusing attention on what is salient and significant. Reminding pupils about what they already know and can do, and building on this knowledge in new contexts provides a means of linking to other experience, perhaps prompting pupils to make links between observations and their knowledge or experience. These and other teaching roles are of importance in ICT-based lessons and need to be borne in mind by teachers managing classroom activity.

7. CONCLUSION

The challenges of integrating ICT into teaching are real and present a barrier for some teachers. Defining specific lesson needs and goals and engaging pupils in the learning process through activities are key skills for teachers. In the ICT context, these skills must be linked to knowledge of what new technology can offer and understanding of how this is influenced by the mode of classroom application. The managerial functions of planning and orchestrating lessons need to embrace the new opportunities offered by ICT, in this sense ICT can augment teachers' existing skills.

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