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The integration of information technology into teachers' decision-making

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Abstract

The teacher-thinking framework has rarely been applied to research concerning the integration of IT into teaching and learning. This paper explores two main aspects of teachers' decision-making where the integration of thinking about IT can have a major impact on their classroom effectiveness: the planning of teaching and learning activities, and the monitoring of student progress during a lesson. Shulman's framework based on different forms of teachers' knowledge is used to examine the current barriers to teachers' integration of IT into their planning. In particular, the consistent finding that experienced teachers merely assimilate IT into existing approaches to teaching topics is considered to result from teachers' reliance on curriculum knowledge and content knowledge of IT, together with a general pedagogical knowledge which does not allow them to exploit IT fully. Further illumination of classroom issues is provided by McIntyre's concepts of 'normal desirable state of student activity' and of 'student progress'. This theoretical analysis leads to practical conclusions concerning future research and the design of in-service and initial teacher education programmes.

Keywords

Secondary education, professional development, teacher education, classroom practice, information technology, teaching methods

1 INTRODUCTION

The evidence for the learning benefits of IT in the curriculum steadily mounts, but the failure of most teachers to make significant usage of the computer in the classroom at secondary education level is also well documented. This is not a paradoxical situation, since the studies which provide the evidence for learning gains have mainly been carried out in laboratory-style environments, or in the classrooms of teachers who have either been nominated as being particularly effective, or who have willingly

come forward to participate in action research, technology innovation or curriculum development projects. Even in the naturalistic studies like those of Olson (1988), the teachers "volunteered to 'adopt' the computer". In the absence of extra support from an expert advisor or project team, it seems that relatively few teachers make significant use of the computer in the natural course of teaching and learning.

In any case, there is no reason to believe that mere usage of computers will result in improvements in learning, nor that studies of usage will divulge any useful evidence about how the promised learning benefits can be achieved. The ImpacT project (Watson, 1993) looked at a number of classrooms with 'high' IT usage and a number with 'low' IT usage. The overall findings were inconclusive, and the greatest illumination was provided by a small number of detailed case studies. These indicated "the importance of the interaction between hardware/software availability and use, and the role of classroom organisation and management and teaching styles". Cornu (1993) calls for an "integrated pedagogy" which "uses new technologies as a fundamental component. Evidence concerning integrated pedagogy is rare, however, and we need frameworks within which to identify and analyse qualitatively the factors involved in the effective integration of IT into teaching and learning.

2 FRAMEWORKS FOR STUDYING IT INTEGRATION

There are many studies concerning the factors influencing teachers' take up of IT (see Gruneberg and Summers (1992) for a review of these), and it is possible to identify frameworks for the study of IT in education which are quite well developed, such as those concerning the 'impact of technology on learning' and the 'institutional support for change'. There has been relatively little attention paid to the 'teacher thinking' framework, however.

Veen (1993) has identified the importance of teaching styles and of teachers' beliefs about their subject and about teaching in general. He highlights the extent to which teachers assimilate IT into existing styles of teaching, and change beliefs only slowly. Carey and Sale (1993) investigated teachers' change to a more 'facilitative posture' when teaching with IT, but found no significant difference. Although Sherwood (1993) found that many teachers who had integrated IT had changed styles in response to the computer, these teachers seemed to have beliefs which pre-disposed them to change and made them highly motivated. Offir and Katz (1995) further highlighted the significance for IT integration of teachers' general motivation to innovate and change practice.

Whilst there is consistent evidence that most teachers are now favourably disposed to the idea that IT can improve learning in their subject, teachers also give consistent responses concerning the barriers to use of IT in their classrooms which they perceive. The list of obstacles almost always includes difficulty of access to computers, software unsuited to the curriculum, and lack of time to prepare lessons with computers (see, for example, Pelgrum and Plomp (1991)). Yet it does not appear that merely providing hardware, suitable software or time to develop skills and plan lessons will enable teachers to fully exploit the undoubted potential of the technology to enhance teaching and to give learners more opportunity to satisfy their individual and group learning needs. Research into in-service teacher education consistently finds that teachers request that more attention is given to classroom implementation.

I shall explore the issues of IT integration within teacher thinking constructs under two main headings: planning lessons and monitoring student progress.

3 EFFECTS OF IT ON TEACHER PLANNING

It is now normal for IT to be integrated into the **planned** curriculum, particularly in England, Wales and Northern Ireland where the learning of IT is part of the statutory requirements and the national curriculum organisations have encouraged an integrated approach. In most cases, these curriculum plans result in IT being part of the curriculum which students receive. But the quality and quantity of students' experience is very varied (OFSTED, 1995), and if the effectiveness of learning with IT is to be improved, teachers must develop the knowledge which enables them to integrate IT into their everyday planning and decision-making.

Shulman (1986) identifies three types of subject knowledge relevant to teaching: subject content knowledge (the facts, concepts and structures of the subject concerned), curricular knowledge (understanding of programmes and materials designed for the teaching of particular topics at particular levels), and pedagogical content knowledge. This last form includes "the most powerful analogies, illustrations, examples, explanations, and demonstrations ... the ways of representing and formulating the subject which makes it comprehensible to others ... an understanding of what makes the learning of specific topics easy or difficult ... the preconceptions that students of different ages and backgrounds bring with them to the learning". Wilson, Shulman and Richert (1987) extend the list of forms of teachers' knowledge to include knowledge of other content, knowledge of educational aims and knowledge of learners. Although all these suggested forms of knowledge are relevant to the issues of IT in education, the subject knowledge types, together with general pedagogical knowledge, appear to have the most significant implications for the issue of integration. I will examine each of these knowledge types in turn.

Curricular knowledge of IT involves knowledge of software, resource packs, and ideas for activities. This knowledge is relatively easy to develop, and enables the teacher to incorporate IT activities into lessons. But unless the teacher can evaluate the activities and relate them to the pupils' developing concepts, they may neither illustrate, explain, demonstrate - or make comprehensible - the topic being taught. Consider, for instance, the science teacher who has obtained a spreadsheet template which models the energy flow for a room. He may be content to implement a straightforward activity where pupils insert data into the model and read off the results obtained. This would miss the opportunity for the 'What if ...' questions which will be needed for the students to gain a real understanding of the relationships amongst the variables.

So, perhaps *content knowledge about IT* itself is a more promising matter. Certainly, an increasing number of teachers are gaining subject knowledge of IT, through initial teacher education, in-service education and training (INSET) and personal use for professional and leisure purposes. However, although this may give teachers the confidence to use IT in the classroom, they may not be able to transform their knowledge for pedagogical purposes in the way that Shulman (1987) describes. Furthermore, few teachers are developing conceptual knowledge of informatics as a discipline, and it is debatable whether the sort of limited experience and training that

is available to most teachers will enable them to construct representations of IT concepts which are adequate to support pedagogical reasoning and action. Consider the history teacher who has learned informally to retrieve bibliographic information from the library using IT, and has received training on the setting up of a file of census records from the 19th Century. She still has some way to go in order to be able to plan an appropriate sequence of instruction and activities for pupils which enable them to pose suitable hypotheses and provide evidence for or against them using this new source of primary data in addition to the more familiar media of text and images.

The integration of IT into *subject content knowledge* is more difficult to achieve, since IT must become part of the way the teacher knows his own subject. For instance, Carey and Sale (1993) quote Becker's (1990) finding concerning teachers of English in US schools that "most lessons related to composing and expressing ideas in writing do not involve the use of computers" and that lessons involving IT "focus on teaching students how to use word processing programs", rather than on the effective or creative use of language. And, whereas, traditionally, mathematicians have come to know about graphical representations of functions through laborious plotting of points and drawing of curves, students can now come to know this topic through typing the relevant formula into a graph plotting program. This difference may well make a fundamental difference to their thinking about whole areas of mathematics. There is a vicious circle operating here; IT can only be part of the way one knows a subject if one has learnt through the use of IT oneself. The more recent entrants to the teaching profession may be in this position, of course, and we must hope that the current impetus for higher education (HE) to integrate IT into teaching and learning will help break this cycle of IT deprivation. Currently, however, there is little sign of even young student teachers thinking about aspects of their subject through IT-based representations.

The role of IT in *general pedagogical knowledge* is covered well by Somekh and Davies (1991), as they set out the changes in pedagogy which may be necessary in an IT learning environment. Together with further points identified by Kennewell (1995), they correspond well with the sort of pedagogical practice which has been found to be most effective generally in bringing about long term learning. As an illustration, Hoyles and Sutherland's work (1989) on learning mathematics in a Logo environment highlights the general knowledge the teacher needs about managing the learning environment so as to give students ownership of their tasks and to support them in their particular approaches.

However, Hoyles and Sutherland's work also shows that merely adopting this general approach is not sufficient without the application of specific *pedagogical content knowledge* to the design of tasks and to intervention during students' work on them, in order to challenge the students' intuitive thinking and stimulate the development of formal concepts. It is this understanding of how the teacher should combine with the IT resources to help the student make progress towards specific learning objectives and enable the level of attainment to be raised.

4 EFFECTS OF IT ON TEACHERS' MONITORING OF LESSON PROGRESS

The analysis in terms of teachers' knowledge types gives us some insight into the relation between teacher thinking and IT learning environments. But there is another level of analysis which also needs to be addressed. Brown and McIntyre (1993) identify two types of concept that teachers use to determine their actions during the course of a lesson: the *normal desirable state of classroom activity (NDS)* and *student progress*. The NDS is the set of conditions of certain behavioural variables which the teacher considers the most appropriate. This is a well-developed concept for experienced teachers, and they will be able to vary the conditions desired, without any apparent mental effort, according to the class, the activity, and the stage of the lesson. Any departure from the NDS will stimulate a brief decision-making process concerning action to be taken, and in most cases will result in an intervention procedure which may be either a routine response or a more considered interaction with a student or students. The 'progress' concept is a dynamic one which allows them to monitor changes in the state of task completion or, more rarely, cognitive change in students. This concept supplements NDS in decision-making, and may cause the teacher to intervene if student progress, individually or as a class, is perceived to be unsatisfactory.

We can see here how a teacher's thinking must change significantly if IT is to be integrated into a lesson, since the IT environment changes the NDS conditions from those which she has developed and refined over the years. Furthermore, the usual signs which indicate student progress (or lack of it) may also be missing, particularly if there are no marks of paper to show for a period of activity. It has been noted (Watson, 1993; Kennewell, 1995) that pupils generally measure their progress only in terms of producing the perceived outcome of the task set, rather than in terms of their actual learning. In an IT environment, teachers often share this product-only view of progress and do not take the opportunities offered for improved monitoring of their students' development of understanding. The teacher must learn to recognise new conditions as desirable and recognise new signs of progress - possibly conditions and signs that would have been contra-indicators in traditional classroom situations, such as movement around the room and animated conversation between students. Although such conditions are not unique to computer-based activity, there may be changes to the way a teacher should react in an IT environment, since the computer is helping to manage the learning and behaviour of the students. In return for this help in management, the teacher can help the computer to aid student progress by intervening with probing questions and challenging tasks.

5 IMPLICATIONS FOR RESEARCH AND FOR TEACHER EDUCATION PROGRAMMES

There are many issues still to be explored concerning the link between teachers' knowledge and their use of IT. It is not clear, for instance, how the adoption of different types of educational IT application - specific CAL packages, flexible teacher tools, and generic software tools - depends on teachers' own capability with IT. We need a greater number of qualitative studies which explore the place and development

of IT in teacher thinking through techniques such as concept mapping, interviews about instances, and stimulated recall.

The above analysis in terms of teacher thinking helps to explain why in-service teacher education centred on the technology or on the curriculum has been found to be inadequate in bringing about the integration of IT into lessons, and work in different countries over recent years suggests that a whole-school approach (Ridgway and Passey, 1991) and a teacher-centred approach (Owen, 1992) should be adopted more widely. Furthermore, it suggests that we should look beneath the surface of the cliché excuses for failure to use technology and give due consideration to teachers' thinking about IT in their day-to-day planning of lessons and monitoring of learners' progress. The next major steps in the widespread integration of IT should be supported by the use of the teacher thinking framework in the design of teacher education programmes. Such programmes should help teachers to develop their general pedagogical knowledge by evaluating curriculum knowledge, planning how new IT subject knowledge may be applied, and seeking feedback from the interactive classroom environment. Indeed, explicit discussion by participating teachers of their concepts of pedagogical content knowledge, normal desirable state and student progress should help them to generalise and transfer what they learn from isolated IT activities in the classroom.

We can also draw conclusions regarding initial teacher education. Veen (1993) suggests that "initial teacher training programs should be playing a more aggressive role in changing the situation", but he concludes that initial teacher education "should not aim at the 'know-how' of ... the actual use of IT in schools", and that instead, later teacher development initiatives should pursue this aim. It would, indeed, be wrong to focus entirely on **technical** know-how in initial teacher education programmes. But all the evidence discussed here indicates how difficult it is to change established practices and that experienced teachers tend merely to assimilate IT into their existing approaches. It is therefore vital that IT should gain a foothold in student teachers' nascent **pedagogical** know-how.

There is no predetermined body of pedagogical knowledge which we can just issue to student teachers, of course. Indeed, they will start to construct their own knowledge before their course of teacher preparation, and will continue developing it (we hope) long afterwards. Their general and subject-specific pedagogical knowledge will interact and grow together. This growth will be very rapid during the early stages of their careers, and so it is vital that IT must start to permeate their planning and decision making during the initial period of teacher education.

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