

TEACHING AND LEARNING WITH ICT NEW TECHNOLOGY, NEW PEDAGOGY?

Peter D. John

Graduate School of Education, University of Bristol

ABSTRACT

This paper provides a broad overview of the papers presented in this symposium. It purports to make some tentative inferences from the early findings and weave these emergent themes into a coherent pattern. In creating these ‘fuzzy generalisations’ (Bassey, 1999), the purpose is to add to the growing professional discourse that is taking place around the pedagogies of new technology. The paper therefore focuses on four issues that have arisen within and across the subject design initiatives: the tension between teaching about or teaching through ICT; the persistence of pedagogical style; the centrality of confidence and competence; and the curriculum contradictions that arise when ICT is incorporated into established subject cultures. The paper also grapples with the thorny issue of the relationship between teachers’ epistemological and personal theories and the use of ICT in their practice. Finally, the overview highlights the sorts of professional development implications that might accrue from the increased use of ICT in classroom communities.

INTRODUCTION

The literature dealing with technology and pedagogy attests to the powerful impact ICT can have on the teaching and learning process. In terms of generic learning, the research indicates that levels of collaboration and communication are enhanced by the use of computers as are knowledge building and thinking skills (Sandholz et al., 1996; Howe et al., 1996; Light et al., 1996; Knight and Knight, 1995; McFarlane, 1997). In various subject areas, there is also evidence that new technologies afford a range of opportunities that can transform teaching and offer improved possibilities for learning (Vaughn 1997; Barton 1997; Selinger, 1998; Haydn, 1998). It has also been claimed that using technology well in classrooms can even enable teachers to be more successful in helping students to be more effective citizens. While there may be some questions surrounding the methodology of these studies as well as some *ex parti* extrapolation, it is certainly true to say that incorporating ICT into classroom situations can and does alter the traditional balance between teacher and learner. Whether this effect is ultimately ‘good’ or ‘better’, however defined, still depends on a host of variables, in particular, the way in which ICT interacts with teachers’ epistemological and personal theories and the concomitant challenges it presents to the established subject sub-cultures of schools. The purpose of this paper is to provide some broader understanding of these challenges and thereby provide more theoretical contour to the various subject design initiatives already presented in the symposium. First, a brief explanation of some of the key theoretical perspectives underpinning the professional development strand of the project and the ways they

have been used to inform both the construction and continuation of the subject design initiatives.

THEORETICAL PERSPECTIVES

In their analysis of the contribution new technologies can make to teaching and learning, Gregoire et al (1996) provided the following with respect to student learning:

- New technologies can stimulate the development of intellectual skills
- New technologies can contribute to the ways of learning knowledge, skills and attitudes, although this is dependent on previously acquired knowledge and the type of learning activity
- New technologies spur spontaneous interest more than traditional approaches
- Students using new technologies concentrate more than students in traditional settings

These positive images are, however, balanced by two further observations of genuine significance:

- The benefit to students of using new technologies is greatly dependent, at least for the moment, on the technological skill of the teacher and the teacher's attitude to the presence of the technology in teaching.
- The skill and this attitude in turn are largely dependent on the training staff have received in this area (p.18)

Despite the somewhat over deterministic inference behind some of the statements Gregoire et al. (1996) are sounding a warning that technology of itself is not a panacea, and that without skilled application by the teacher its benefits may soon recede. The crucial element remains the way in which the technology is incorporated into pedagogical patterns and this is in turn dependent upon the impact it has on the epistemologies and personal theories of the teachers deploying the technology in their classrooms. A number of educational reformers have argued that for teachers to be successful in constructing new roles for themselves they need to open up these theories to scrutiny by coming together in discourse communities where various types of knowledge and expertise are shared in rich conversations about practice. These communities then serve to challenge patterns of classroom teaching and learning that have historically been resistant to change. This is due in part to the powerful enculturation that schools engender giving rise to what Bruner (1996) has called a pervasive 'folk pedagogy'.

This 'folk pedagogy' evolves from the integration of a species-specific theory of mind and a culturally well-established 'folk psychology'. The latter constitutes a set of beliefs about knowledge, learning, thinking, motivation, the 'self', and other psychological categories. They are often intuitive, tacit, and sometimes derivative, and in terms of school teaching are usually embedded within an established subject

sub-culture which is itself reinforced by generations of practice. From a socio-cultural perspective, critics have claimed that too often the existing cultures in schools and traditional 'applied' professional development programmes do not always value or support critical and reflective explorations of teaching and learning which is the *sine qua non* for change. Ball (1994) has characterised many of the discussions in professional development activities as mere 'style shows' that provide few opportunities for meaningful reflection and growth. And as a result teaching remains:

A smorgasbord of alternatives with no real sense of community, there is no basis for comparing or choosing from among alternatives, no basis for real and helpful debate. This lack impedes the capacity to grow. (p.16)

Several recent developments have tried to counteract this process. The Community of Learning project (Wineburg and Grossman, 1998), for instance brought together teachers of history and English with university based educators to read and discuss key texts, to analyse practice, and to design lessons that challenged traditional norms. All brought different forms of knowledge with them and none were privileged. As a result entrenched ideas were challenged and new ideas were embraced that had a direct bearing on classroom practice. Similarly, Davis and Sumara (1997) described the development of a year long community of practice that enabled the participating teachers to appreciate how their practice was influenced by prevailing conceptions of teaching and learning even as they were attempting to reconceive their practice. A final exemplar comes from the work of Westheimer and Kahne (1993) who argue that if teachers are to foster community building in their own classroom contexts they must experience 'opportunities for interaction, mutual dependence, and identification with a group'.

A crucial component of the project has been the germination and sustaining of groups of individuals in what we have termed subject design teams. They have come together in pursuit of a shared experience; one that will both challenge and enhance their practice beyond the life of the project. Of crucial significance has been a range of discussions concerning the social nature of knowledge and the interdependence of social and individual processes in the 'co-construction' of that knowledge (John-Steiner and Mahn, 1996). We are of the belief that if thought, learning and the construction of knowledge are not just influenced by social factors but are in fact social phenomena (Rogoff, 1994), then it makes sense to provide occasions for interaction, joint deliberation and the collective pursuit of shared goals. Finally, we are of the opinion that teachers should not only understand social constructivism as a theory, but should also live it. Only then will they be able to make the necessary reflective transfer (Schon, 1988) that will enable them to incorporate such ideas into their practice.

Three design principles therefore inform our work. **Firstly, we have a focus on pedagogical content knowledge**, and the underlying orientation toward teaching held by each teacher. Grossman (1990) describes this as an overarching conception of

how to teach a particular subject. It can be thought of as a conceptual map that guides pedagogical decision making both in the planning and interactive phases of teaching. We hold that a teacher's orientation reflects a set of knowledge and beliefs regarding a particular epistemology, but because it belongs to a family – a subject sub-culture with traditions and antecedents – there is enough inter-subjectivity to facilitate individuals working together while simultaneously allowing room for individual variation in practice. When attempts are made to develop new or innovative practices this orientation often forms an intuitive screen through which professional development and the teaching reforms are interpreted. Research in several subject areas has demonstrated that teachers only tend to adopt new practices if the assumptions inherent in the innovation are consistent with their epistemological beliefs and personal theories.

In terms of the use of ICT Dwyer et al (1994) and Yocum (1996) found that teachers with a more constructivist orientation were more likely to select open ended software over more behaviourist types. Similarly, Maor and Taylor (1995) found that the ways in which teachers used new technology varied according to their epistemological orientation. More recently Gobbo and Girardi (2002) in a study of the relationship between teachers' beliefs and the integration of ICT in Italian schools found that both personal theories of teaching and levels of competence did influence utilisation levels as well as modalities of use. These tended to run parallel to the pedagogical style and epistemological views espoused by the teachers. Finally, Dwyer and his colleagues (1991) conclude that even where teachers were dedicated to the investigation of the potential of technology to enhance learning, they were often held in check by personal and institutional habits and by variations in the provision of equipment and appropriate classroom structures. Bearing this literature in mind, we set out to address these issues within each design initiative seeing ICT use not as an end in itself but as a catalyst to spur on a shift from transmissionist forms of pedagogy to more social constructivist approaches. I will return to this issue of orientation below when describing some of the ways in which individual teachers and teams have confronted this aspect of their work and moved to new positions.

Secondly, there is an emphasis on the classroom as a community. This builds on Woolgar's (1988) idea of scientific discovery occurring at the 'workbench'. Workbench communities typically involve small groups of individuals who work closely together in on-going collaboration to solve problems of immediate and joint concern. Woolgar (1988) points out that at this fundamental level science looks very much like problem solving in other domains. He argues, however, that their work is fundamentally dependent on the principles and acceptance of the wider professional community of scientists. The workbench scientists therefore have to set their work within this larger context and show publicly that they have met accepted expectations. An analogous 'classroom community' would therefore be characterised by small collaborative groups - in our case teachers, teacher educators, and researchers – who mutually support the growth of the community throughout its life span. The community members would be highly interactive and interdependent,

working together to use and evaluate the tools at their disposal (material and intellectual) both from their own and from the wider community.

Thirdly, we have pinpointed intellectual activity as a key element. Following Lave and Wenger, 1991; 1998) and Rogoff (1994) we aim to transform the understandings, roles, and responsibilities of our community members as they collaborate with knowledgeable others. To understand what this means in terms of professional development it is important to conceptualise teaching as an intellectual activity involving complex judgements and decision making where knowledge is utilised from a number of domains. Our design initiatives are therefore predicated on the belief that the intellectual activities of planning, enacting and reflecting upon one's teaching are central to professional learning. And that these processes are iterative and longitudinal. One of the guiding lights is therefore not only the levels of change observed within each teacher's practice but also the sorts of transformations that take place in each teacher's classroom culture. This will of course impact on the most important element, improved student learning.

The three perspectives are predicated on the idea that neither top down nor bottom up forms of professional development are sufficient. The former suggests a model in which knowledge is transferred by experts to novices; while the latter suggests a model in which one is left to discover knowledge by oneself or with peers (Rogoff, 1994). Whilst accepting that professional learning can occur in both these settings, it is our contention that neither will lead to sustained changes in practice. Furthermore, if the advancement of knowledge, represented in new forms is a fundamental goal, then a classroom community set within a wider professional and academic constellation would appear to offer more in terms of knowledge validation, dissemination, and utilisation.

THOUGHTS, THEMES, THREADS

We are cognisant of the fact that the papers in this symposium are diverse and represent only a small portion of the activities taking place within each design initiative. We are also aware of the danger of presenting 'ideal types' of activity where the problematics of teaching and learning with ICT are airbrushed out. Hence the attempt by the authors to home in on the messiness, confusion and complexities that surround the implementation process. Despite these variations, we believe that there is enough material to make some tentative inferences and to weave together the themes and threads into a coherent pattern. So what commonalities and disjunctures can be discerned amongst the various design initiatives presented? What are the implications for the introduction of new technologies into established subject sub-cultures and the pedagogical traditions that sustain them? How are the teachers and the students in the subject design initiatives reacting to the challenges presented by ICT and what changes are taking place – if any – within their established teaching styles? Are new pedagogies emerging alongside the new technologies or are old pedagogies being adapted? And finally, in what directions are the design initiatives

progressing and what problems, possibilities, portents and peculiarities are coming to the fore?

Teaching about or teaching through ICT

The first issue relates to what Selinger (2002) has called the tension between teaching about ICT and teaching through ICT. Many of the papers illustrate the importance of changing the classroom context as a pre-requisite to enhanced ICT use. This is seen as particularly important if greater collaborative work is to be fostered. However, as Jayne Prior and Celia Tidmarsh have shown such changes of themselves are not enough to bring about the desired interactions. They point to the fact that the teacher needs to plan the collaboration carefully in a way that takes into account the varying levels of ICT competence and confidence displayed by the students. If not then there may be a disjunction between what the learner is attending to and the learning itself, which can result in confused subject understanding and task frustration. If the ultimate goal is to make the application a tool that can support and enhance learning then students have to be enabled to make the tool work for them (Selinger, 2002). However, teachers need to be aware of cognitive overload where, according to Chandler (1995), repetitive visual text and accompanying auditory support might impose an extraneous cognitive load on working memory-as it did in the vignette described by Prior and Tidmarsh. The dangers highlighted by the authors also mirror those of Hoyles et al (1994) who argue that collaborative work around ICT needs careful preparation and skilled support. Most importantly, tasks need to lend themselves to group work and the software should be appropriate and the hardware sufficient for the task.

Steve Godwin's portrait of the use of *Omnigraph* within a series of four lessons on the properties of quadratic equations highlights the importance of the above point. His description of the teacher 'scaffolding the task' with support materials that focus on the process of exploration, emphasises the salience of 'a framework of structured independence together with pupil autonomy' (Hoyles et al., 1994, p. 214). He comments:

These experiments were scaffolded by the teacher who designed the tasks so that the students were directed to experiment with certain parts of the equation. This helps and enables the students to keep all the variables that make a quadratic fixed apart from one, and thus more clearly see its effect in the representation. If the students were given free reign it might make it far more difficult to see the effects of the individual parts since the changing the variables together might mask each other's effects. The structuring of the experimentation by the teacher helps to address the problem that Goldenburg talked about with respect to the fact that he felt that students found it difficult to perform meaningful experiments. There is always the danger that the software may allow a lot of random playing without thought or reflection but by structuring the play and providing tasks for the students their learning can be directed.

Both Rosamund Sutherland et al's and Marina Gall's presentations point in similar directions although they extend the concept of scaffolding to include the use of extensive modelling – both stylistic and substantive - by the teacher, and the subsequent need to reinforce concepts and practices through metaphor, allusion and exemplar. The most important aspect appearing to influence the learning of the pupils, however, is the way in which the teacher structured the activities and paid attention to the detail of how these were presented at the outset. Lesson 5 is particularly illustrative. Here a stand in teacher brought a new pedagogical style to the class and instead of the usual careful, structured modelling, a worksheet was presented. As a result, levels of student engagement with the application were much lower than those observed in previous lessons and instead the class became obsessed with completing the sequential tasks. The outcome driven nature of the lesson combined with a lack of effective modelling showed that there is nothing inherent in a particular piece of software that will automatically drive learning. Such phenomena can lead a teacher to conclude that the technology was irrelevant, rather than encouraging reflection on whether the activity could be presented in a different way so as to make better use of the software. As the authors conclude:

The way in which Pat (the usual teacher) elicited pupils' own comments about polygons and their properties, in the whole class work, appears to be important from the point of view of engaging pupils in the mathematical work. Crucial to this whole process of teaching and learning mathematics is the making visible of developing conceptions and working with the whole class and the interactive whiteboard were an important aspect of this. Could pupils have been encouraged to ask more questions and how would this have effected their investigations and learning? This is something which can be probed in the revised design initiative.

Embedded in the story of this design initiative is the way in which the teacher conjoined the technical lexis of mathematics (which underpins Cabri) with everyday language. Items with a uniquely technical meaning (usually Latinate in origin such as parallel, quadrilaterals and bisect) have a specific meaning and a number of vignettes show that understanding can be enhanced by the supportive use of appropriate metaphor and analogy. Taken further (as the presentation shows), it is at this point that the software begins to recast traditional knowledge for the purposes of creating new knowledge in the mind of the student. This creation of congruence through linguistic representation is, according to Sutherland et al., essential if software such as Cabri is to be used successfully. However, it is important to qualify this finding with the fact that a change of teacher combined with a new pedagogical style did not automatically bring with it similar linguistic-mathematical understandings. Thus showing the pervasive effect of pedagogy even within a micro-world environment. In the music initiative, *inter alia*, the importance of iconic representation mixed with colour likewise helped the children to develop a musical vocabulary that could be significant in the building of a solid platform for further more formal understandings. Such visual learning together with the simplicity of the software allowed the children to grasp many of the fundamentals of tone, variety and rhythm. Again this exemplar

points to the need for pedagogical subtlety when using ICT in creative subjects. The teachers moved from orchestrators of the class to being managers and facilitators while simultaneously maintaining the classroom ambience and control necessary for active learning. This ‘help-line’ approach emerged as the design initiative progressed – it was not planned or factored into the lessons *a priori*, thus illustrating the generative nature of the project and the importance of serendipity.

The importance of pedagogical style

This leads on to a second issue arising across a number of the design initiatives, namely the importance and continuation of a strong teacher role. This is inevitably connected to the epistemological orientations and personal theories of each teacher; however, such roles inter-collate with established school subject sub-cultures to create a particular ‘pedagogical style.’ This is an amorphous concept and can encompass several dimensions, but of crucial importance is the fact that variations of style will be influenced by the pervasive subject sub-culture that has become embedded within the department or faculty in which the teacher is located. This juxtaposition of personal style and subject cultural factors is an interesting one given the prominence (and scarcity) of ICT within certain subject areas. It can also be problematic for some subjects in that the use of ICT is predicated on the idea of collaborative or more individualised learning. This is augmented by the idea that new technology conveys implicitly to children that they can work at their own pace. However, established teaching styles are often based on synchronicity, while the curriculum demands a sequencing of content so that students can be ‘moved’ through at a particular speed. This ‘batch processing’ idea is challenged directly by ICT, as are many of the verities of established antecedent subject sub-cultures (Goodson and Mangan, 1995).

Sasha Matthewman’s paper on the meaning of multimodality in English is a case in point. Using a framework proposed by the New London Group based on the concept of multiliteracies, she highlights three tensions that go to the heart of the problem. The first explores the tension between the language of technology and the key terms and concepts associated with the subject culture of English. The second looks at the strong collective code that pervades the current curriculum and examines the ways in which ICT enhances or diminishes the boundaries that exist between and among subjects. The third addresses a broader issue and relates to the perennial problem of the relationship between freedom and control, and the ways in which ICT encourages or limits creativity. Her portraits from practice are instructive as she illustrates how traditional discourses within English mesh easily with the discourse of technology but nevertheless points to the strong sense of subject identity displayed by the teacher both formally and informally. He is anxious to maintain a level of content discretion, which may in part be due to his powerful sense of teacher role but is also linked, as Matthewman points out, to uncertainty as to how multimodality equates fully with the discipline of English. His emphasis on maintaining standards against the sloppiness

of other subjects and his (slightly light hearted) desire for the students to represent English with a warm colour all point to a desire to maintain subject solidarity.

In the history and to some extent the geography presentations, the teacher went further and retreated to the comfort blanket of the subject and his antecedent pedagogical style. This consisted of a narrative approach underpinned by a deeply held set of personal theories emanating from an extensive 'folk pedagogy'. These appeared to be at odds with much of the *raison d'être* of ICT. He was at the outset concerned about ICT tail 'wagging' the subject dog, and expressed some anxiety that too much ICT in the classroom might encourage a 'by-passing of the brain.' Nevertheless, he did feel that using new technology might allow the children greater flexibility in their learning hence the expectation (mistaken) that collaboration might automatically take place. This view of ICT as a surrogate tutor is misleading and can lead to pedagogical confusion and de-motivation. When the expected learning failed to materialise, the teacher had no real answer, except to fall back on accepted pedagogy, despite being confident with the software. As a result the students were often active but not inter-active and their learning was limited.

Nevertheless, some interesting findings did emerge. In the history lessons, the most technically able child (who was also of lower ability) did show a better understanding of history than the others in the group, hinting at the notion that technical ability is an essential pre-requisite to learning. In the geography class, similar instances were noticed. This accords with Selinger's view (2002) that expertise with the technology must be balanced with the subject learning. Also, as many of the presentations indicate, if handled well ICT can increase levels of motivation, particularly amongst the apparently 'least able'.

These features, and others, are also present in many of the other subject design initiatives. It seems that subject teachers do not wish to surrender to the technology but prefer to integrate it into their established subject and personal pedagogical style. In particular, they do not want to replace subject learning with technical training – put simply they are resisting the displacement of the academic by the technical. This is due to the fact that subjects carry with them certain assumptions about 'knowledge', 'worthwhile learning', the 'good student' 'effective practice', and what constitutes 'acceptable performance.' In some subject areas, for instance, mathematics and science, where the take up of ICT has been more widespread, enthusiasm may be more obvious perhaps because its use fits more snugly with existing practice. In contrast, teachers in other subjects – history, geography, and English, for example, may feel they have to modify the use of ICT in order to ensure that it does not disrupt their established patterns of teaching or their place in the curriculum. This process of co-option means they do not have to surrender to the machine but adjust and accommodate pragmatically to avoid colonisation. In many ways this adjustment within an established pattern is the way in which teachers in general have reacted to the educational reforms of the last two decades.

Competence and confidence

A third, and in some ways related issue, is that in all of the scenarios presented in this symposium, the established pedagogical style of the teachers was not fundamentally disrupted. Despite variability, most of the teachers tended not to re-work their lesson plans or pedagogy to incorporate the new technologies, instead they modified their routines thus allowing ICT to merge with existing patterns of teaching and learning. ICT therefore became another resource – albeit a powerful one. There were shifts but most were in part a reflection of the ability to accommodate their teaching styles to the potential of the new technology. As such they were assimilating the new tool – and the amount of assimilation depended a great deal on levels of confidence and competence displayed. Pat, for instance in the quadrilateral portrait, was still coming to terms with Cabri and one could feel her confidence building as she used it in various teaching and learning situations. In the music presentation it was self evident that both Jo and Natalie were maturing rapidly both in terms of their confidence and competence with ICT. In fact, their mutuality did not dissemble their expertise but enhanced it. The history teacher, on the other hand, was overtly competent with the technology but this ability could not mask his maladroitness pedagogy and his professional vexation when his subject knowledge and its presentation became a barrier to learning. Too often he took it for granted that the greater proximity provided by the application and the machine would in itself provide the necessary tuition. In contrast to other subject areas, mathematics, music and Modern Foreign Languages, for instance, working individually, in pairs and in larger groups, appeared to enhance learning, although this factor alone is not enough for us to make any predictions regarding axiomatic relationships between ICT and enhanced learning outcomes.

An adjunct to this relates to the role of peers in the collaborative process. What sort of role should they play? Can they be guided to help improve the interaction of others? Or is peer mentoring in an ICT context too serendipitous – too dependent on the whims of individuals who may lack the motivation and skills to ‘teach’ themselves and their fellow learners? The deployment of ‘high status pupil-coordinators’ may in the long term be advantageous but at present the idea needs further clarification and more extensive research. What is clear, however, is that some students take to ICT quicker than others and that differentiated and in some cases highly structured tasks may be required to ensure collaboration and learning.

It is also clear that each teacher’s orientation and personal theories influence the model of teaching and learning adopted, although the greater the confidence in the technology the greater the propensity for use. This motivation factor is vital to the success of the project and beyond. In fact it is part of a loop of professional learning that incorporates a number of variables including competence, theories of teaching, subject perceptions and knowledge as well as levels of professional satisfaction. It is therefore posited that once improved learning outcomes or increased classroom interaction and motivation become noticed, so the teacher’s level of confidence will

improve and the variables (outlined above) will re-enter the loop adjusted in a more favourable position. This is the iterative process hinted at in our design initiatives, and is one that forms the core of our professional development process.

Curriculum contradictions

It must also be borne in mind that while not advocating technological determinism, the current curriculum – its structures, philosophies and traditions – has its genesis in an era when advanced technology was in its infancy. Additionally, too often the apparent gains made with ICT (Sasha Matthewman's paper is illustrative here) were not assessable within the current curriculum framework. The National Literacy Strategy highlights this paradox. On the one hand, in most cases technology morphs easily with accepted pedagogies to produce in some cases real advances in learning and understanding, but such developments are often exogenous to the accepted template. Tim Shortis's paper for instance, shows in graphic detail how a novice teacher moves through the stages of instrumentalism characterised by a 'teaching to the curriculum' approach, to a more rounded and deeper understanding of spelling techniques, in particular, the use of phonics. Simultaneously, his participation in the project combined with his close working relationship with the researcher produced a transformation in the teacher's subject knowledge, pedagogical principles, and classroom practice. The software then becomes a tutor and a tool, providing him and his students with a liberating approach to literacy. This thinking and acting 'outside the box' challenges and confounds accepted practice and is central to pedagogical change.

In the ICT and Geometry design, the 'drop down menus' approach in Modern Foreign Languages and the spelling and phonics initiatives similar tendencies were apparent. The unhurried discussions about methodology at the outset allowed innovation to germinate thus producing genuine partnerships. As a result, the teachers involved felt a sense of shared ownership and in consequence their motivation and confidence increased as the initiative developed. This was also evident in music where the co-researcher and practitioners allowed ideas to take root before embarking on the lessons thus creating a sense of community and mutuality. As a result the process and product were more sustainable and the levels of confidence and competence increased exponentially.

CONCLUSIONS AND IMPLICATIONS: TECHNOLOGY AT THE CROSSROADS?

There have been some who have feared that the introduction of new technologies into classrooms would result in a heightened sense of social efficiency where a mix of systems, instructional packages and various forms of technological wizardry would create its own technical fix to the perceived problems of education. Hartley (1998), for instance, warns against the hidden curriculum of this panopticized pedagogy where policy makers can mandate practice from above through the seemingly value neutral technology. The evidence from this collection of papers would suggest that

the use of ICT is being embraced but not imposed. This is due in part to the collaborative nature of the project but is also a product of a genuine desire by the participants to move away from the over-simplified debates and instead concentrate on the creation of rich environments where their students can use their minds well. The evidence also suggests that there are multiple pedagogical possibilities inherent in technology based teaching and learning. However, the success or otherwise of such innovations rests on the teacher's ability to recognise that learners develop their own preferred style and this can be harnessed through a mediated, technology rich environment.

Such observations imply that if changes in teaching and learning are to be fundamental and long lasting then a different model of professional development is needed. At the moment we have too much 'innovation stretch' where the gap between pioneers, and the medium and non-user is wide. For this 'long tail' to be shortened new and innovative forms of professional development need to be instigated. Currently, most of the professional development to date has been based on the idea of 're-tooling', that is they are structured to augment the existing curriculum by providing specific training to groups of teachers in the mechanics of the technology. What is needed is what Watson et al (1999) call a 're-forming' approach whereby training is built on a staged process through which teachers have to pass in order to change their practice. Taylor (1998) identifies these stages as the orientation phase, the adaptation phase, the evaluation phase, the innovation stage and the institutionalisation stage. At present many of the teachers in our 'classroom communities' have moved through the first four phases albeit at different speeds and levels of complexity. The innovation stage is beginning to take root in some initiatives although developments are uneven. The broader institutionalisation phase will take more time but one of the long term objectives of the project is to create the conditions whereby intra and inter-subject innovations become commonplace and the schools become 'beacons' for new technology pedagogy.

Further professional development implications also arise out of the project. We are trying to build supportive networks where there is a communal construction of knowledge. We hope to further enrich and extend these beyond the boundaries of the project. In so doing we hope to persuade school management teams, local education authorities, and policy makers at local and national level that it is not only provision of equipment and its use that matters. The presence of technology alone will not improve practice or education. But technology integrated effectively into learning environments by reflective and flexible educators will help in the restructuring of classrooms and schools (Watson, 2002).

The role of researchers and theorists is vital in this process. They should not be seen as 'providers' of skills and abilities but as reformers and people who can provide leadership and direction to school based 'change agents.' This, as some of the presentations have shown, can be brought about through increased communication and mutual 'scaffolding' between and among team members. In general, most of the

teachers in the subject initiatives reported an increased sense of professionalism and a greater feeling of self-efficacy after working collaboratively. Finally, when dispersing our ideas and practices it is important that teachers should engage directly in the process of learning that is being offered to the students. This will help teachers get on the inside of the innovation as well as increasing their confidence, competence, experience and understanding of the software and its pedagogical implications. This form of 'authentic' professional development is vital if ICT use is to move beyond mere novelty.

To conclude, the answer to the question 'new technology, new pedagogy?' must therefore for the moment remain only partial. Dwyer et al (1990) claim that a new forms of teaching and learning will inevitably result from greater familiarity, confidence, flexibility and success that is attendant upon increased and long term use. As we have shown, in some classrooms there is indeed a genuine shift taking place from seeing technology less as a patient tutor and more as a tool which can facilitate inquiry and critical thinking. However, in so doing teachers have to accept that learning in such an environment is often chaotic, messy, may have no tangible beginnings and ends and might breed more confusion before genuine understanding occurs. In this scenario, levels of isomorphism are low and the teacher has to accept that the learning space must become part of a paradoxical relation – a space of difference and experimentation where agency and understanding go hand in hand, and where opportunities for learning open up greater possibilities that had previously been imagined.

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