ABSTRACT

Schools are ideal settings for action research. With the coming of the Internet and digital learning the way students learn has changed. The way teachers need to teach has changed. Today it is likely that students know more than their teachers about ICT. No wonder that the integration of ICT across the curriculum in NSW has been problematic. Most teachers can use computers. They use them at home. However, due to a variety of reasons, the majority of teachers do not use computers in the classroom. Teachers need learning and support to become confident with using ICT within their classroom curriculum. Constructivist-based disruptive ICT innovation is often promoted as the pedagogy to replace current classroom teacher practice. Many teachers are not ready to make the shift. However, teachers appropriately resourced and supported can facilitate appropriate, meaningful ICT-based learning. Whilst ICT in the classroom is not simply about changing paper for digital files, this may be the place to start. This paper explores a Participatory/Cooperative epistemology that may be more applicable than Constructivism to ICT-based knowledge accumulation and construction. This leads to a consideration of Connectivism, a learning theory to support digital learning and knowledge development approaches such as dialogic literacy.

INTRODUCTION

In grappling with the issues confronting teachers tasked with integrating ICT across their subject curricula a comprehensive literature review of the issue was undertaken. The outcomes from this literature review are summarised in the first section of this paper as background. The literature review was followed by in-school research and action in two schools. The detail of this research is presented as a Case Study (Net-ICT). The outcomes of this action research generally confirmed the predications from the literature review. This led to the suggestion of some ideas for integrating ICT across the curriculum. The final section of this paper is a reflection on what was learnt from the literature and action research and re-consideration of the best way forward for integrating ICT within the classroom curriculum. This reflection leads to a proposal for consideration a post-constructivist epistemology and an emerging learning theory for the digital age.

A benefit of working in a school, what Foucault (1997) might term a panoptic mechanism, is that it provides an ideal setting for community-based action research by teachers and students in a community of practice. Schools allow students and teachers to think and explore ideas such as Friere’s (1970) aspiration that through discourse (connected, dialogic literacy), the nature of education will change, that previously oppressed students (and teachers), now connected and conversing globally could lead to action in a process of permanent liberation.

LITERATURE REVIEW

An extensive literature review was undertaken as part of this study. It is summarised under a number of key consideration.

THE WAY STUDENTS LEARN HAS CHANGED: The emergence of the ubiquitous, rich-content, interactive Internet has heralded a paradigm shift for schools. Teachers now compete for their student’s motivation and attention against an ever-increasing plethora of noisy, converged, rich multimedia knowledge sources our students take for granted. According to MCEETYA (2005) our student’s learning is ‘situational, complex, diverse and rapidly changing. Learning is inquiry focused
requiring application, construction and creation of knowledge. Learners connect understanding across disciplines, applying key concepts and evaluating multiple solutions within ethical frameworks’. Strange but more often than not, what we as teachers are presented with at the end of our student’s learning engagements is a non-accredited definition copied straight from Wikipedia. Is there perhaps a gap between the rhetoric of the epistemology and the reality of the classroom?

**THE WAY TEACHERS NEED TO TEACH HAS CHANGED:** With the Australian and New Zealand Ministerial Council on Education, Employment, Training and Youth Affairs’ (MCEETYA, 1999) Adelaide Declaration of National Goals for Schooling in the 21st Century the Australian school education sector embarked on a reform agenda. Early this century the New South Wales (NSW) Government announced that all Year 10 (School Certificate) students would undertake a compulsory Computing Skills Assessment ‘to measure students’ knowledge, skills and understanding in the use of information and communications technology (ICT)’ (BOS, 2001). The NSW Board of Studies (BOS, 2003) dutifully prepared DRAFT ICT skills descriptions (they remain DRAFT even as of today). In 2004 the new mandatory Years 7-10 syllabuses were issued with ICT integrated within the outcomes and content. At this juncture, ICT became the responsibility of the classroom subject teacher.

**STUDENTS KNOW MORE THAN THEIR TEACHERS (ABOUT ICT):** According to Spender (2003), ‘Australian teachers now readily report that many of their students know more about the new technologies than they do themselves’. Dr Tim Hawkes, the headmaster of the King’s School in Parramatta believes that students are on a cusp of a revolution in learning that requires teachers to adapt to their cyber world. Hawkes believes that students are addicted to technology. ‘It is not part of their life – it is their life’ (Doherty, 2005). Lawson (2004) reports that the teaching profession has been de-skilled by the introduction of digital technologies, that the traditional education model is not appropriate for an information age and that teachers needed to re-evaluate their methods of teaching and retrain themselves. Elliott (2004) also articulated the sentiment that learners today know more than their teachers. Similarly, Fogarty (2005a unpub.) found that students performed on average better on some ICT dimensions in a 2005 Computer Skills Assessment Trial test in spite of the fact that this was in areas that their teachers indicated they needed professional development.

**COMPLEX INFORMATION AND COMMUNICATION TECHNOLOGY:** Smoothly implementing ICT in the classroom curriculum to address the mandated requirements of the curriculum can be a complex project for schools and teachers (refer Figure 1). Like any large, complex computer project it needs to be well planned, designed, executed, evaluated and continuously updated and maintained if it is to be successful. It is generally held that over seventy percent of large-scale computer projects fail to achieve their initial objectives. The classroom by its nature poses a unique and challenging environment for teachers implementing ICT. More important than the technology is the underpinning pedagogy. Pedagogy must drive the technology (not the other way around).

**PROBLEMS WITH INTEGRATING ICT WITHIN THE CLASSROOM:** The integration of ICT within NSW classrooms has been problematic for students, teachers and schools. There is an inequitable assessment regime for the first cohort of students (at least) – they only had had three years (rather than four) to prepare for the first mandatory Computer Skills Assessment Test in 2006. Many teachers lack ICT experience within the classroom. There is no established community of ICT practice for subject teachers. Schools are uncertain of their ability to facilitate appropriate outcomes for their students due to ICT resource issues and the fuzziness of appropriate pedagogy for ICT learning.
MOST TEACHERS DO NOT REGULARLY USE ICT WITHIN THEIR CLASSROOM: A preliminary review of literature relating to the integration of ICT across the curriculum confirms the thesis that teachers do not typically use ICT within their classroom, let alone integrate it within their curriculum. The American academic Cuban (2000) found that forty to fifty percent of teachers NEVER use computers in the classroom. Between thirty to forty percent of teachers were occasional (about once a month) users of computers in their classroom. Only ten to twenty-percent of teachers were serious users of computers in the their classrooms. Another US-based researcher Becker (2000) generally supported Cuban’s findings reporting that ‘Cuban correctly characterizes frequent use of computers’. More recently, Scottish research has supported the claim that the promotion of technology into subject classrooms has not significantly changed teaching and learning (Conlon, 2003).

Locally, the findings are similar with only eight percent of teachers reported using computers daily with their students (Phelps, Graham and Kerr, 2004). Leung, Watters and Ginns (2005) also recognised ‘that there is slow uptake by teachers of Information Communication Technologies in school classrooms’. Fogarty (2005b unpub.) found that over eighty percent of teachers in a school indicated that they needed extensive professional development for most of the basic skills related to the introduction of ICT across the curriculum.

As suggested by Conlon (2003), when the use of technology in classrooms by specialist computer and technology teachers is deducted, the actual number of general subject classroom teachers regularly using computers in their classrooms is likely minute. Russel, Bebell and O’Dwyer (2005) found that teachers are making little use of technology.

MOST TEACHERS CAN USE COMPUTERS: Cuban (2000) found that whereas teachers were unlikely to use computers in their classroom they did regularly use computers for administration and for personal productivity. He debunked many popular myths about teacher’s use of computers. He found that eighty percent of schoolteachers have computers at home and use their machine to prepare lessons, communicate with their colleagues or search the Internet.

THE BARRIERS TO INTEGRATING TECHNOLOGY IN THE CLASSROOM: The barriers to teacher integration of ICT across the curriculum are well documented. They include: intractable working conditions; external demands on teacher time; the conservative nature of traditional classroom culture; teacher’s resistance to change; need for teachers to unlearn traditional approaches; lack of time and availability of computers; technical problems with unreliable technology; lack of (learning) resources; lack of teacher basic ICT skills; varying competency levels of students; time constraints; access to ICT literate teacher assistance; the fact that ICT is not part of the present school culture, intractable workplace conditions and external demands made on a teacher’s time. (Dailhou, 1991; Cuban, 2000; Cuttance, 2000; Hayes, 2004; Probert, 2004; Vrasidas & Glass, 2005).

A further issue identified by Fogarty (2006 unpub.) is the ‘crowded’ nature of the NSW school curricula. The comment by a Geography teacher who was surveyed is quite telling: ‘Geography is a half-subject in terms of periods per week yet it still has Civics &Citizenship, Geographical Skills and Fieldwork, research skills, ESL skills, students with disabilities … in classes. Without support, ICT is a bigger challenge.’

WHAT TEACHERS NEED TO BE SUCCESSFUL WITH ICT: Steketee (2005) identified that teachers: need a comprehensive pedagogical approach, need up-skilling (but mentions that skills alone are not enough) and are more likely to use ICT after experiences within their own subject area. Other research (Lim et al.2004; Budgen, 2003; Downes et al., 2001; ITTE, 1997; ACOT, 1995 and Dailhou, 1991) has found that teachers seek ICT PD that is:

- Planned, developed, delivered and supported by other teachers who use the technology for a similar purpose and who are also proficient in teaching adults.
- Offered to teachers who have access to hardware and software they can practice with in their classrooms or at home.
Delivered within the school or classroom with adequate time to allow teachers to learn, practice, and apply new concepts and techniques and supported by handouts.

Accepted throughout the school community as an ongoing activity, not a single event and continuously evaluated and improved.

A gradual, progressive implementation, an evolution within which the stakeholders gradually adopt an alternative perspective of teaching and learning.

Voluntary or offering credit, stipends, and/or release time.

Appropriate to teachers’ current attitudes and expertise.

Flexible in allowing teachers to use what they learn in a variety of ways appropriate to their individual situations;

Designed as small-group collaborations among teachers.

The same research indicates that teachers seek ICT PD content that:

- Is subject, task-specific;
- Focuses on actual uses of technology that will serve curricular goals;
- Builds on teachers’ existing knowledge about curriculum;
- Has a strong pedagogic focus on how computers can be used in the classroom, and
- That provides opportunities to experiment and reflect on new experiences.

CASE STUDY: NET-ICT - THE INTEGRATION OF ICT ACROSS THE CURRICULUM IN TWO SCHOOLS

Fogarty (2006 unpub.) undertook a pilot study on integrating ICT across the curriculum in Year 10 in two secondary schools (one a state school; the other a private school). The pilot engaged teachers and students in three projects: a Stage 5 English project to create a visual advertisement; a Stage 5 Geography project to create a population pyramid and a teacher’s multimedia project where participating teachers were taught to construct a multimedia website in three-easy steps in less then fifteen minutes.

With the English project, the initial reaction of the classroom teachers when asked how they would go about integrating ICT for the task was basically ‘we are English teachers, what has ICT got to do with us?’ After it was explained that the requirement was now part of the mandatory English syllabus the teachers indicated that they would require a fellow teacher (expert in ICT) to develop the required learning resources, book the required computer resources and assist them with the initial delivery of the classroom learning. A student task activity sheet and teacher ‘How to’ guides were developed and the teachers assisted with their deployment to students. At the end of the pilot the teachers reported: ‘the activity worked well’; ‘it really fitted in well with our work’ Many of the students produced near excellent advertisements.

There was a similar story with the Geography pilot. The teacher comments: ‘all steps explained clearly’; ‘it was a great activity – one I will use again and again.’

The multimedia project for teachers was a result of eighty-two percent of teachers in the school reporting that they lacked multimedia competency (Fogarty, 2005a unpub.). Over forty teachers were invited to attend over a two-week period, either during lunchtime or after school—eleven accepted. The participating teachers constructed a multimedia (text, image and sound) website on Wikispaces in less than fifteen minutes. The teachers who completed the learning evaluation (the majority of those that participated) reported that they ‘agreed’ that the activity was well aligned with their needs and with the competency requirements and something a teacher could use. Evaluation comments included: ‘well presented in an easy comprehensible manner’ ‘excellent, aim achieved’ and ‘very important’.

Overall, the pilots were deemed successful. They demonstrated that classroom teachers, adequately resourced and supported could facilitate appropriate ICT-based learning to their students.
Some of the issues raised informally with the author by teachers participating in these pilots included questions and statements about: why subject teachers are expected to teach ICT skills; the general lack of training and experience with ICT; the need for a team combining subject and ICT specialists; lack of reliable access to technology and a preference for small group work (on the basis that it allows one, perhaps more competent, student to assist others).

One aspect of the Net-ICT project that failed to realise its potential was the establishment of a community of ICT practice of the various subject teachers within the schools. The Net-ICT project manager (the author) spent some time and effort establishing ICT-based support and information portals. Neither was utilised by participating teachers (due in some part to the fact that resources were provided to them – as requested – in paper format for copying to students). Unfortunately, the nature of the project did not allow for this aspect to be further investigated.

**SOME IDEAS FOR INTEGRATING ICT ACROSS THE CURRICULUM**

The outcomes from an extensive literature review, and some local action research in schools, leads to some ideas as to just what is the best way forward for integrating ICT into the classroom curriculum.

**WHERE IS THE BEST PLACE TO START?** In considering the best way forward for implementing new learning systems Zemsky and Massey (2004) suggest a four-stage process:

1. The first step is with PowerPoint and Electronic mail, followed by
2. Course management systems, then
3. The development of specific targeted digital interactive resources, and finally
4. A total redesign of courses to ensure a more interactive learner-centred model.

In embracing disruptive pedagogies Hedberg suggests ‘that it is not simply changing paper for digital files’ (Mitchell and Hedberg, 2006). There is a variety of computer-mediated learning management systems available to teachers to assist them develop, manage and deploy learning such as: WebCT, Blackboard, Moodle or LAMS. The reality is that most teachers in schools are not ready or able to effectively engage with such technologies, nor is the necessary institutional support in place in most instances.

It would seem that the first step any institution should consider in moving forward with the integration of ICT across the curriculum is to develop an operational strategy to match the ICT and pedagogical competencies of teachers with the technological readiness of the school. The short-term goal of such a strategy would be to manage the technology environment in such a way as to assure teacher confidence with ICT within the classroom. Then there is a clear need (based on the in-school research) to develop professional ICT development plans for teachers. When teachers have a stable and accessible technology environment, appropriate skills and time to integrate ICT, it is likely that they will also possess the confidence to do so. Only at this stage is it likely that a non-ICT expert classroom teacher would consider a Learning Management System.

Initially, when considering the introduction of a Learning management System, perhaps simply changing paper for digital files is an appropriate place for teachers to start. As Cuban (2000) identified, teachers use computers at home to create learning resources for their students. Why not initially simply upload these resources to a website (such as a protected educational space at Wikispaces). The creation of a course Noodle (refer Figure 2 above) comprising materials that can be collaboratively developed by the cohort of teachers.
assigned to a subject course and available to all students in that course is relatively simple (as demonstrated by Fogarty’s Multimedia pilot for teachers.). Such an approach seems to be envisaged by Metros (2003) in looking at how teachers will move learning materials from passive interest to dynamic interaction to achieve enhanced learning outcomes.

REFLECTION
Before embarking upon a major project to assist integrate ICT across the curriculum it was considered prudent to reflect on the ontology, epistemology and learning theories that could underpin such an initiative. The following reflection considers an alternative epistemology and an emerging theory concerned with learning in a ‘connected’ classroom.

ENTER DISRUPTIVE PEDAGOGIES: In the first section of this paper the literature review examined many of the dimensions involved with the traditional methods of attempting to integrate ICT within the classroom. At the other end of the learning spectrum is the vision of disruptive pedagogy (Hedberg, 2006b). Disruptive ICT-based pedagogy is cast, after Christensen (1997), in terms of a new innovation that will eventually replace current classroom practice. According to Hedberg (2006b) the success of disruptive innovation such as ICT in the curriculum will depend on a revolutionary move away from replicating traditional classroom-based pedagogy to be replaced by constructivist-based disruptive pedagogy. Constructivist-based Disruptive Pedagogies are seen as a new way of teaching that can support MCEETYA’s and the NSW Government’s vision for ICT in the classroom.

Hedberg (2006c) suggests that key dimensions of disruptive pedagogies include:

- An emphasis on high order thinking skills (Jonassen, 1996),
- Dialogic literacy, (Bereiter & Scardamali, 2005)
- ‘Democratised’ resources,
- Knowledge scaffolding,
- The generative personal construction of understanding,
- The representational framing of ideas,
- Student engagement (Metros, 2003), and
- Social interaction (Salmon, 2004).

Most ICT-based learning pedagogy tends to be constructivist in nature. MCEETYA (2006b) proposes that educational leaders ‘support experiential, constructivist learning in schools’. Hedberg (2006b) suggests that ‘if they are to support a constructivist (potentially disruptive) pedagogy, ICTs need to be associated with a range of interactive activities.’ However there may be a case to reconsider constructivist-based learning theories in light of the development that has occurred in ICT.

IS A NEW EPISTEMOLOGY NEEDED? Constructivist pedagogies are not new, teachers have used them in varying forms for many years with varying degrees of success. Constructivism, in its purest guise is focused on how an individual constructs knowledge and meaning. Taken to its logical conclusion, constructivism can lead to radical changes in the teaching profession as evidenced by Corpus Christie High School (CCHS, 2006) advertisement where teachers become ‘learning advisors’ supporting the growth and learning of a small group of students in a technology rich learning environment.

The new opportunity, afforded by the Internet, of ‘connecting’ students to knowledge in new and exciting ways, means teacher practitioners may favour more of a Social Constructionist epistemology where the emphasis swings more to group/shared knowledge construction. However, it could be that an emerging epistemology (Participatory/Cooperative) provides a better inquiry paradigm than either Constructivism or Social Constructionism to inform digital learning in a ‘connected’ classroom. The Post-Constructivist Participatory/Cooperative epistemology was articulated by Herron and Reason (1997) and further developed by Guba and Lincoln (2005). Unlike a Constructivist epistemology, where knowledge is typified as being individually constructed or a collective reconstruction coalescing around consensus, in a Participatory/Cooperative epistemology, knowledge is considered in the
context of ‘an extended epistemology of experiential (direct encounter), propositional (conceptual) and practical ways of knowing (knowing how) and an axiology that affirms the primary value of practical knowing’ (Herron and Reason, 1997). According to Guba and Lincoln (2005) in a Participatory/Cooperative epistemology, knowledge is conceived as accumulating in communities of inquiry embedded in communities of practice.

According to Flyvbjerg (2001) the idea of ‘practical knowing’ is rooted in the Aristotelian idea of *phronesis* (practical and context-dependent deliberation about values) in a taxonomy of knowledge that also considers *episteme* (theoretical knowledge) and *techne* (pragmatic and context-dependent practical rationality). For an educational practitioner, such a taxonomy of knowledge appears to support consideration of learning across cognitive (knowledge), psychomotor (skills) and affective (beliefs, attitudes and values) domains (as promoted by Benjamin Bloom). A similar knowledge theme is evident in the discourse of Greenwood and Levin (2005) who typify social science knowledge as bridging concrete practical intelligence and value-based reflectivity.

More and more, knowledge within the ‘connected classroom’ may be emanating from social and information collectives. Brown (2002) terms such collectives the ‘social mind’ within communities of practice where most knowing comes into being. Greenwood and Levin (2005) discourse on ‘collective knowing’ as a key knowledge concept. Skrbina (2001) cites the concept of the ‘group mind’ as being derived from Plato’s concept of Panpsychism. Its contemporary manifestation he refers to as the ‘aggregate mind’. Siemens (2005) cites Brown (2002) when arguing that the amplification of learning, knowledge and understanding by information collectives is the epiphenomenon of Connectivism.

In the milieu of a school, the teacher is institutionally cast in a didactic role within a socially conceived ‘community of practice’ of students. Traditional teacher-centric behaviourist-based teaching methods, such as Gagné (1985), have latterly been replaced with Constructivist (or Social Constructionist) student-centered learning paradigms (with varying degrees of support by teachers). However, the emergence of disruptive pedagogies (Hedberg, 2006b) associated with the ‘digital classrooms’ and the integration of ICT across the classroom curriculum pose new (and often daunting) dilemmas for teachers. This leads to the question: Are new learning theories needed for the digital age?

IS A NEW LEARNING THEORY FOR THE DIGITAL AGE NEEDED? Recently, a new theory of learning applicable to the ‘digital-age’ has emerged, Siemens’ (2004) Connectivism, where learning (actionable knowledge) is a process that occurs within nebulous environments, not entirely under the control of the individual (be they teacher or student within the classroom). White (2005:5) points out that ‘according to Siemens, behaviourism, cognitivism and constructivism focus on learning that occurs “inside a person” and fail to address learning that occurs “outside of people.”’

Siemens (2004) identifies the key principles of Connectivism as:

- Learning and knowledge rests in diversity of opinions;
- Learning is a process of connecting specialized nodes or information sources;
- Capacity to know more is more critical than what is currently known;
- Nurturing and maintaining connections is needed to facilitate continual learning;
- Ability to see connections between fields, ideas, and concepts is a core skill;
- Currency (accurate, up-to-date knowledge) is the intent of all Connectivist learning activities;
- Decision-making is itself a learning process;
- Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality;
- While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.
Connectivism, with its emphasis on diversity of opinions, connecting specialised sources and decision-making, might be an appropriate overarching learning theory to support concepts such dialogic literacy (Hedberg, 2006c; Bereiter and Scardamalia, 2005 and Abbey, 2005).

CONCLUSION
The stark implications from the literature review are that teachers are highly unlikely to integrate ICT into their curriculum until a range of perceived issues are addressed. However, the in-school pilots described in the Net-ICT case study demonstrate that teachers, appropriately resourced, can effectively implement ICT within their classrooms. However, before embarking on large-scale projects of implementing ICT across the curriculum, in the light of post-constructivist epistemologies and learning theories, would it be wise to consider what exactly is the best way forward for schools.

Further reflecting on the significance of a Participatory/Cooperative paradigm within a connected classroom focused on developing dialogic literacies, Siemens’ (2004) Connectivism raises the question: Is it possible to achieve Friere’s (1970) aspiration that through discourse, the nature of education will change and that students (and staff) can be liberated?
REFERENCES


UNPUBLISHED SOURCES
