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Towards a definition of the integration of ICT in the classroom

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Towards a definition of the integration of ICT in the classroom

Despite the contention that the effects of technology integration are generally not well documented (Hayes, 2004), there has been an increasing use of information and communication technology (ICT) in Australian schools (Bruniges, 2003; Finger, 2003; Finger & Trinidad, 2002; MCEETYA, 2005; Meredyth, Russell, Blackwood, Thomas & Wise, 1999). There has similarly been a demonstrable incremental movement of ICT from the peripheral to the mainstream of school life as progress is made towards meeting the specific national aim to "integrate information and communications technology into all facets of education and training, including the administrative functions and e-business models required to support learning" (Bruniges, 2003, para. 4). The purpose of integrating ICT has been stated as being "to improve and increase the quality, accessibility and cost-efficiency of the delivery of education, while taking advantage of the benefits of networking learning communities together to equip them to face the challenges of global competition" (Bruniges, 2003, para. 6). As a background to (and arguably driving) these directions in education, ICT is being charged with the capacity to transform society (Fullan, 1993, 1997; Fullan & Miles, 1992; MCEETYA, 2005) and, consequently being held to be central to school reform (Prestridge & Watson, 2002; State of Queensland, 2002).

The continuing demand for wider implementation and integration is similarly evidenced in state and national goals for education most notably the Adelaide Declaration on National Goals for Schooling in the Twenty-first Century (MCEETYA, 1999) which specified that students should be confident, creative and productive users of new technologies, particularly information and communication technologies, and that they should understand the impact of those technologies on society (Goal 1.6). The Education and Training Reforms for the Future (ETRF) in Queensland included ICT as one of its four target areas of reform (Education Queensland, 2004) and the federal Department of Education, Science and Training (DEST), in its 2004 review of teaching and teacher education included the action that: All teacher education programs prepare prospective teachers for the digital age where ICT is an important tool in information and knowledge management and integral to student learning (DEST, 2004, Action 31).

In the initial release of Education Queensland's *ICTs for Learning Strategy*, the then Director General of Education offered that:

> ICTs are at the core of teaching and learning in the 21st Century. Queensland's future depends on how successfully we integrate ICTs in the curriculum and daily learning and teaching. … Many teachers already use computers to enliven teaching and inspire students. In order to build a 21st Century schooling system …, we need teachers to understand how ICTs promote higher order thinking skills and deepen understanding in all key learning areas.
>
> (State of Queensland, 2002)

The cited statement draws attention to the key notion of integration and its qualifying adverb "successfully." It also equates ICTs with "computers" and named the key agent for their use as being the teacher. It speaks of, but does not define, a 21st Century schooling system but hinting that ICT is at the "core" of this system confirming its perceived centrality. It also brings into focus the notion that successful ICT integration is a desired but ill-defined and intangible outcome (see also Milton, 2003; Warschauer, 2000).

Australian education systems and independent researchers are concurrently developing instruments to measure the integration of ICT in the classroom (Fitzallan, 2004; Jamieson-Proctor, Watson, & Finger, 2003; Trinidad, Clarkson & Newhouse, 2004). While the measurement of a "successful integration" could be reduced to a survey of ICT infrastructure in Australian schools and could be easily achieved (such as in counting machines, noting bandwidth, calculating money expended or deriving student:computer ratios), fundamental problems of definition and measurement arise in the integration of ICT. Finger, Jamieson-Proctor and Watson (2003) contended that "unless more sophisticated notions of describing ICT curriculum are developed, researchers run the risk of promulgating severely restricted ways of measuring it" (p. 69).

The theoretical purpose of this paper is to problematise the concepts which underpin the measurement of ICT integration and in turn, threaten to restrict the adoption of consistent and generally-applied definitions of terms. The logistical purpose of this paper is to serve as the introduction to a conference symposium on the measurement of integration of ICT in Australian classrooms. It will begin with a definition of ICT and then move into a brief discussion of the defining and measuring of ICT integration with a particular emphasis on the issues of concern facing potential researchers in this area.

ICT

The acronym ICT is taken to stand for information and communication technology or alternatively information and communications technology. The differing number of the word "communication" is significant in that the singular form is concerned with human interaction while the plural is generally taken to refer to the whole field of data communications infrastructure. At its simplest, the former or singular form is the process or outcome while the latter or plural is about the technology itself. The acronym ICT can also take a plural form (technologies) where it is understood to entail the specific devices or processes which collectively make up the "Technology." This pluralised form (particularly in Queensland) is sometimes written as ICTs. The term ICT must be seen as an evolution from the antecedent and more narrowly defined term IT (information technology) which maintains its usage in government, business, industry and in relation to tertiary and other academic courses dealing with such areas as programming, database design and expert systems. In the United States, synonymous terms such as "technology" and "educational technology" are used. A useful definition of ICT is that it:

> … generally relates to those technologies that are used for accessing, gathering, manipulating and presenting or communicating information. The technologies could include hardware (e.g. computers and other devices); software applications; and connectivity (e.g. access to the Internet, local networking infrastructure, videoconferencing). What is most significant about ICT is the increasing convergence of computer-based, multimedia and communications technologies and the rapid rate of change that characterises both the technologies and their use.
>
> (Toomey, 2001, para. 3)

While it effectively refers to a broader domain, ICT tends to mean computers and their peripheral devices (as deduced in the previous citation from the Director General, Education Queensland (State of Queensland, 2002). But the term "computer," particularly in a school setting, is a connotative rather than denotative term because it may refer to anything from high-speed connected state-of-art machines to something which is dated, stand-alone, or poorly maintained. The configuration of computers in schools may range from individual

machines, to distributed models, and to sophisticated networks (Ryan, 1999). There is no standard school configuration of machines and this has much to do with systemic and school purchasing and maintenance policies as it does to the obsolescence and unreliability of the machines themselves. A question was asked in the Queensland Parliament on May 25, 1995 which revealed the lack of standardisation in a typical Queensland state secondary school at a time when computers had only been widespread in schools for a little over a decade. The Hansard entry reads as follows:

> Mr HEALY asked the Minister for Education—
> With reference to the fact that the Toowoomba State High School's computer stock was (a) 7 Apple Computers—15 years old, (b) 18 Sperry Computers—10 years old, (c) 13 CCS Computers—8 years old, (d) 4 CCS Computers—6 years old, (e) 1 Epson Computer—6 years old, (f) 16 Compacts—4 years old, (g) 1 Computer—6 years old, (h) 30 terminals—Business Ed Centre and (i) 11 Hunts—4 years old at the end of 1994—Will he immediately review this situation where a student population of 1,250 has access to just 71 computers, 25 of which are more than 10 years old, and bring the ratio up to the promised one computer for every ten students?
>
> (Queensland Legislative Assembly, 1995/2000, para. 156)

The current inventory of the cited school is not known at time of writing but it could be cautiously conjectured that some of the machines included in this list to State Parliament may still be in use. If not, then a similarly disparate and motley collection of machines of different capacities and configurations may be being used by students and be constituting the learning environment in which teachers are trying to produce students who are "creative, confident and productive users" of ICT (see MCEETYA, 1999). It is unlikely that this school is unique.

Amidst unfounded and inflated claims that ICT "is transforming the way individuals learn throughout life"(DEST, 2005, para. 7), it is important to draw attention to the research findings that insist that ICT infrastructure on its own does nothing to effect change in a school with the often-repeated contention that "while new digital technologies make a learning revolution possible, they certainly do not guarantee it" (Resnick, 2002 , p. 32). It has similarly been noted that "technologies by themselves have little scaleable or sustained impact on learning in schools" (Honey, McMillan & Carrig, 1999 in Hayes, 2003, p. 3) and that what, in fact, is critical is "how" the technologies are used (Reimann & Goodyear, 2004). An influential U.S. study diminished the role of technology itself to act as a catalyst for change concluding that change and reform were about pedagogical beliefs (Dexter, Anderson & Becker, 1999) and Lightford (1995, in Lechner, 1998) offered that "it is the use of technology to create learning communities, a human intervention and not the technology itself, that may reform education" (p. 22). A tangential understanding is of the valency of ICT, or rather how it is "embodied in *things*; such as ICT tools which 'carry' a set of pedagogical beliefs or preferences" (Reimann & Goodyear, 2004, p. 12). While the computer is itself not a catalyst, its valency as a conduit for communication, collaboration and knowledge building has the potential to transform learning.

Defining ICT integration

It is surprisingly difficult to locate a direct and consistently applied definition of ICT integration despite its having been an aim of educational systems for some time (Cuttance & Stokes, 2000; Milton, 2003) and one of increasing contemporary interest (MCEETYA, 2005). The term "ICT integration" connotates a range of learning environments from a stand-alone

computer in a classroom to a situation where the teaching is done by the computer through pre-packaged "teacher-proof courseware" (Laferrière, 1999, p. 3).

There is evidence to suggest that the term "integration" is often used interchangeably with the more plebeian "use." It is generally taken, however, to reflect a change in pedagogical approach to make ICT less peripheral to schooling and more central to student learning. In some instances, it is taken to be one of a set of typologies referring to how ICT is used in Australian schools (Downes et al., 2001) particularly Type C which is used to describe the introduction of ICTs as an integral component of broader curricular reforms that are changing not only how learning occurs but what is learned. This is encapsulated in the views that "not only can technology help children learn things better, it also can help them learn better things" (Roschelle, etc, 2000, p. 78) and that "better learning will not come from finding better ways for teachers to instruct but from giving the learner better opportunities to construct" (Papert, 1989, in Lechner, 1998, p. 22).

The ubiquity of the term "integration" in relation to ICT in education is illustrated by the titling of two influential U.S. teacher education texts. One of these, *Integrating Educational Technology into Teaching* (Roblyer, 2004), is in its third edition while the other, *Integrating Technology for Meaningful Learning* (Grabe & Grabe, 2004), is in its fourth edition. Neither text defined the term "integration" but instead spoke of it in circuitous ways. For example, Roblyer (2004) globally offered that "like teaching itself, integrating technology into educational practice is challenging work, full of exciting possibilities and complex problems" (p. E-vi). The meaning and consequences of the term are presumed.

The same ubiquity of usage – particularly without a lack of precise definition – has arguably led to the term being reduced to rhetoric or dismissed as jargon. A posting to a professional email list offered that "personally I feel that the word 'integrate' is as foul as any four letter word ever uttered by an angry student. I feel the need to vomit every time I hear someone natter on about 'integrating' ICTs" (G. Washburn, email to qsite-community, April 15, 2005). There are therefore those who see "integration" as critical, challenging and exciting and others who see it as confronting or ill-conceived.

To integrate is to seamlessly combine components, parts or elements into a complex but harmonious whole. The notion of seamlessness is implicit in the definition that ICT integration is the degree to which ICT "vanishes into the background" of the classroom (Fluck, 2003). Davis and Shade (1999) drew an interesting parallel between technology and language contending that, like literacy, "technological fluency" can be achieved if technology is "integrated into the classroom environment" (p. 225). This invisibility is similarly consonant with the seminal *Genres of Technics* (Ihde, 1979) which positioned human beings in a continua of engagement with technology from intentional and reflexive correlations (completely external to it) to background relations that is, being completely surrounded by and oblivious to the technologies. At its extreme, there is more here than sublimation as what is created is a technological cocoon where the technology cannot be ignored because of our reliance or dependence on it. Wisdom can be drawn from the notion that "environments are not passive wrappings, but are, rather, active processes that are invisible" (McLuhan & Fiore, 1967, p. 68). An exemplar of ICT integration of interest to this study is that described in a tertiary pre-service teacher education course (Lloyd & Ryan, 2004; Ryan & Lloyd, 2003). In the tertiary unit under review, integration is achieved by positioning ICT at the centre of the unit making it the context rather than the content for learning. In this centrality, it becomes the context for learning. There is an argument for the substitution of "integrated" with the

term “embedded” to better explain the conceptual placement of the ICT in relation to the learner, the content and the teacher.

Hay (2001) proposed a way of thinking about ICT integration which encapsulated its semantic definition as a combining of elements. Her hypothesis was that ICT integration is an equation made up equally of three domains, namely, Information Literacy, Information Policy, and Knowledge Management. What is of interest with this definition is that it speaks of processes rather than of hardware infrastructure and is exclusive of operational ICT skills. It is interesting in its partial encompassing of the accepted sequence of data-information-knowledge (Bellinger, Castro & Mills, 2004; Clark, 2004) where machine operations are used to complement and expedite human processes of logic and knowledge construction.

Despite the lack of a clear definition, “integration” is seen as a key outcome. Scaplen (1999) noted the presumption that teachers would “know” how to integrate offering that:

> One main area of support that is sometimes overlooked is that concerning the actual integration. So much attention is paid to learning how to operate the hardware and software, that it almost seems taken for granted that a teacher will instinctively know how and when to exploit it in the learning context. (para. 8)

This observation inadvertently offers three important concepts towards the definition of ICT integration. The first is that integration is distinct from an operational use of hardware and software. The second is that it is not defined or explicated but presumed to be part of a teacher’s tacit knowledge or general understandings (as previously noted in the titling of the text books). The third is that it is conditional knowledge (after Anderson, 1997) in that it relates to the “how” and “when” ICT is used in the classroom defined in the cited text as being when “exploit[ed] in the learning context.” These concepts, tangentially, raise a critical issue for professional development in ICT as a transference is generally presumed between the learning of operational skills and the application of those skills in classroom activities with McKenzie (2001) reporting that “a large percentage of teachers feel ill prepared to use … [ICTs] in curriculum rich ways” (para. 26).

Roblyer (2004), in making visible the supposedly tacit knowledge of teachers regarding ICT integration, described a Technology Integration Planning (TIP) model of five phases. These are to:

1. determine relative advantage
2. decide on objectives and assessment
3. design integration strategies
4. prepare the instructional environment
5. evaluate and revise integration strategies

Of interest to the discussion in this paper is Roblyer’s (2004) third phase relating to integration strategies which involved teachers in making decisions about (a) instructional approaches, (b) curriculum approaches, (c) grouping, and (d) sequence. What can be drawn from this is that integration can be embedded in teaching practice as opposed to being extraneous or peripheral to it. It is also apparent that integration needs to be planned and purposefully enacted.

Returning to the semantic definition of integration, ICT integration might also be a seamless combination of school-wide factors. A longitudinal study conducted by the British

Educational Communications and Technology Agency (BECTA, 2002) concluded that the essential factor for effective ICT integration was school readiness, which, in turn, was described as comprising of resourcing, school leadership and general teaching. Kozmo (2000, cited in Milton, 2003) offered that successful integration could be demonstrated by its affects which included a culture of innovation, pedagogical goals (student-centred, authentic), collaborative learning, robust and reliable hardware, and access to expertise. Further to the notion of integration as a combination of parts, Milton (2003) offered that the component parts included the school context, the technologies provided, the technical skills of teachers, technical support, maintenance and upgrading, pedagogical skills and preferences of teachers, availability of resources, and finally, the skills and motivations of students. She reduced this list to concerns with connectivity, content and capacity. A review of these studies leads to an understanding of ICT integration as a complex and multi-layered phenomenon which needs to include a survey of infrastructure as well as more intangible measures of pedagogy.

The conditions for successful ICT integration emerging from the ACOT research studies (conducted from 1985-1995) included administrative support, physical configuration of learning spaces, and teacher collegiality (see Apple Computers, 2003; Sandholtz, Ringstaff & Dwyer, 1989, 1997). One of the ACOT reports (Haymore-Sandholtz, Ringstaff, & Dwyer, 1992) specifically concluded that there are four conditions for the effective integration of ICT in education. These may be summarised as being:

1. the adoption of innovation and the creation of a collaborative environment are complementary conditions for change;
2. innovations introduced at only one level of the system are not likely to succeed;
3. the introduction of technology to schools can act as a catalyst for change, thereby enhancing restructuring efforts; and,
4. teacher commitment to an innovation will not occur until they see a positive impact on their teaching.

An alternate and emerging way to define ICT integration is a step within a broader trend to school reform (Fluck, 2003; Fullan, 1993, 1997; Garvey, 2004; Nichol & Watson, 2003). Transformation is taken to be the final of the set of typologies referring to how ICT is used in Australian schools (Downes et al., 2001) previously alluded to in this paper. This “type” is classed as Type D which describes the introduction of ICTs as an integral component of the reforms that alter the organisation and structure of schooling itself. Hayes (2004) described the agency of technology in transforming the effects of schooling through its capacity to amplify, mediate, validate and subvert while Laferrière (1999) contended that “the creative integration of ICT in the curriculum is likely to bring significant changes in the way schools carry out their educational mission” (p. 12).

Trinidad, Clarkson and Newhouse (2004) incorporated the notion of integration as progression to transformation into a planning and analytical framework developed for schools in Western Australia. The five layers of their framework were inaction, investigation, application, integration and transformation. A “critical use border” was identified within the first layer (Layer One) between application and integration with integration being deemed to be the stage where the use of ICT becomes critical to the support of the learning environment. Transformation is the stage where the teacher is able to take on leadership roles (formal or informal) in the use of ICT and be knowledgably reflective on its integration by themselves and others. The second layer (Layer Two) is referred to as Integration and Use (I & U) and here speaks of integration as a component of the overall outcomes. Integration can thus be

seen to be both a process and an outcome. It is also the condition or state in which the learning is reliant on the technology to provide the context or environment for learning.

While the notion of integration being a step toward transformation is an innovative one in practice, the role of ICT as a potential catalyst for change has been contended in the literature for some time (see for example Fullan, 1993, 1997; Fullan & Miles, 1992) and can be said to be in line with current systemic approaches. It is a process which would require the four previously cited conditions for success in integration (as suggested by Haymore-Sandholtz, Ringstaff, & Dwyer, 1992) to be evident.

From this brief review, it can be seen that there are multiple and often conflicting definitions of ICT integration. It is, in one instance something which is non-existent and in another, so seamlessly embedded it is invisible. It is regarded as critical practice by some commentators and empty rhetoric by another. What is known, however, is that integration can be a state, an outcome and also a process; and deciphering which is which may well be the key to developing effective measurement instruments.

Measuring ICT integration

If the defining of ICT integration is problematic, then so too is its measurement (Cuttance, 2001). An interesting contention emerging from the literature is that integration is a rare occurrence with some researchers suggesting that while the classroom use of ICT has increased, "it is still unusual for a teacher to regularly integrate technology into the learning experience" (Willis, as cited in Proctor, Watson & Finger, 2003, p. 68). Some authors (see, for example, Cuban, 2002; Schofield & Davidson, 2002) are unequivocally critical in their description of the non-use of computing resources in schools and Trinidad et al. (2004) found it necessary to include an "inaction" level in their model. It is not possible to empirically measure something which does not exist. This section will attempt to identify some of the issues facing potential researchers in this area.

The first issue of concern is the identification of what actually constitutes new ICT-mediated learning experiences. Where integration is observed, it may well be a mere transposition of "old" pedagogies and practices into a new environment. The teacher may have replaced the blackboard for the electronic whiteboard but may retain fundamental views about teaching and learning. Hayes, Schuck, Segal, Dwyer, and McEwen (2001) noted in their study of ICT use in NSW schools that where "teachers generally integrate computer-based technology into their existing teaching strategies. … they were using technology as a replacement tool to provide tasks similar to those not mediated by technology" (p. 12). What is observed and noted as being part of 21st Century schooling may well be transposition rather than transformation with the actual classroom practice falling short of the previously noted "critical use barrier" (Trinidad, Clarkson & Newhouse, 2004). An acknowledgment of this issue implies that the measurer of ICT integration needs to be cognisant of what might be called *a transposition paradox* where new media is being used but there has been little or no pedagogical change. The intent of the teacher may be to meet mandatory requirements or community expectations to use ICT rather than to provide truly new integrative or transformative learning experiences.

Consonant with the previously-cited definition offered by Trinidad, Clarkson and Newhouse (2004) that integration is where the use of ICT becomes critical to the support of the learning

environment, Reimann and Goodyear (2004) argued that learner-centred ICT use requires ICT to be "a necessary component … [and that] without ICT the method would not be feasible" (p. 21). Education Queensland (n.d) in their online *ICTs Curriculum Integration* course emphasised the notion of ICT being integral to learning experiences as well as being integrated within the curriculum. This is a countering of what Richards (2005) has called "add-on" activities suggesting that these are unlikely to transform traditional or transmission models of teaching. This suggests a need for measurement of integration to consider the extent of reliance on the technology or more pertinently, its centrality to the learning environment.

It is of use at this point in the discussion to interject the widely-used descriptors of the classroom use of ICT as being learning (a) about, (b) with, or (c) from the technology. The oldest of these is *learning about* which generally refers to computer science or courses based on operational skills. This equates roughly with Type A use from the typology described by Downes et al. (2001). The descriptor *learning with* emerged along with the movement for ICT to be cross-curricular rather than isolated. It implies an enhancement of learning where the technology is used to amplify student understanding or capacity. What this generally means in practice, however, is that ICT is used as a presentation medium (which Richards (2005) would refer to as "add on") and aligns with Type B use (Downes et al., 2001). The third descriptor, *learning from* has emerged from the use of the Internet (as an information source) and from increasing use of programmed courseware. There is an argument for a fourth descriptor, *learning through* the technology which extends the notion of amplification and, more importantly, allows for collaboration and reflection both on- and off-line.

Irrespective of descriptors and typologies, what is apparent is that change in classroom use has occurred and this is arguably because of changes in the technologies themselves. This is evident in Toomey's (2001) observation of a trend to "whole school reform" through the use of ICT by suggesting that:

> Many schools are now experimenting with new approaches to teaching and learning. They are doing so because they consider it a valuable way to encourage the development in young people of higher order thinking skills such as synthesising, analysing and evaluating, problem solving abilities, working in groups and other lifelong learning skills. They also recognise the relevance of these skills for life in the information economy. (para. 23)

There is little in this cited text which would indicate an "add-on" ethos. Change is clearly evident and, given this, the need for new measures become important. In response to this, it has been argued that "we need to dissolve and reconstruct the classroom in a connected world" (Lightford, 1995, in Lechner, 1998, p. 22) and with it, our ways of understanding and measuring it must also change.

The base measure of integration studies is usually the teacher with a specific emphasis on ICT skills and affective dimensions such as confidence and anxiety (see for example Scaplen, 1999). This, in many ways, parallels the research being conducted in determining the inhibitors and facilitators of teachers' use of ICT in the classroom (see for example, Downes et al., 2001; Godfrey, 2001; Lloyd & Yelland, 2003). While it is widely held that the "crucial component in the use of ICT within education is the teacher and their pedagogical approaches" (Cox, Webb, Abbott, Blakeley, Beauchamp, & Rhodes, 2004, p. 4) and that teachers are "the rank and file implementers of change" (Bailey, 2000), this paper contends

that simply surveying the teacher in isolation masks the complexity of integration and the issues and paradoxes inherent in its measurement.

A study by Scaplen (1999) is typical of those which purport to measure integration but do not define it and instead measure "use." The data collection for this study was drawn from a questionnaire in two parts. The first part related to gathering background information with the following questions being posed:

1. What grade level(s) do you teach?
2. How many students are in your class(es)?
3. What subject areas do you teach?
4. How many computers do you have in your classroom?
5. Does your school have a computer lab?
6. To the best of your knowledge, how and based on what criteria, was the decision made to allocate computers as they are in your school?

These questions position the teacher as the focus of the study. The second part of the questionnaire referred to "actual" classroom use and, to meet this end, the following questions were posed:

7. What types of software do you use most frequently with your students in the classroom?
8. What are the titles of some of the most useful software that you use in your classroom?
9. What physical preparations/precautions have you made in the classroom in order to optimise use of the computer?
10. Are there any teaching/learning strategies that you employ to facilitate being able to schedule students at the computer?
11. What classroom management techniques do you use to free students up to use the computer or to allow yourself time to work with them there?
12. What are some of the strategies employed to facilitate the actual use of the computer?

The questions posed by Scaplen (1999) were not attributed to the extant literature nor to any broader systemic objectives. Some (particularly Questions 1-5) are descriptive and provide data which could have been obtained through observation or through a questioning of a school administrator. It is difficult to see a causal connection between the number of computers in a classroom, whether or not the school has a computer lab and the nature of ICT tasks being set. This is a corollary of the previously cited discussion over the inability of ICT, without human intervention, to do anything or to effect any change in any learning environment.

The questions in the second part (Questions 7-12) of Scaplen's (1999) study are equally unlikely to measure integration. The first of these are, in essence, descriptive (in listing software) and are similarly looking for a causality which may not exist. The final questions (Questions 9-12) in the survey are somewhat repetitive and seem aimed at identifying logistical issues of classroom layout and structures such as rosters and activity centres to enable students to use computers. The study was of a one-computer classroom and the questions presuppose a particular environment, that is, a single classroom with a small number of computers which may or may not be networked together or connected to a wider school network or the Internet. It does not fit all possible configurations of laboratories, "pods" or stand-alone machines.

The Scaplen (1999) study is somewhat typical of studies being conducted to "measure integration." It could be contended that such studies might be useful in describing isolated environments and, further to this, only doing so on a physical or logistical level. Such studies do not broach understanding curricular integration or to any notion of transforming the practice of teaching and learning itself.

Where the teacher is not the focus of measurement, it may alternately be "school." If so, there is the problematic issue of there being no single identifiable entity as a whole school approach to ICT integration, in real and tangible terms, and, that students, within the one school, may have very different experiences of ICT. In a pre-school or primary setting, this may be dependent on the teacher's predisposition, expertise and teaching goals or on access to reliable resources. In a secondary setting, it may also have to do with subject area demands and practices and to logistical matters such as timetabling. In some schools, ICT (in various guises) is treated as a stand-alone subject taught by a specialist while in others a cross-curricular approach is adopted (Department of Education, Training and Youth Affairs, 2000; Lloyd, 2003). Extrapolating on the notion of complexity of school settings (Hennessy, Ruthven & Brindley, 2005; Tolmie, 2001; Zhao & Frank, 2003) and the evidence of observation, it could be posited that no two schools use or integrate ICT in the same way. There will also be little coherence within schools as some teachers enthusiastically adopt ICT-mediated learning experiences and others inventively avoid them (Lloyd & Yelland, 2004).

In a recent research study with extensive field studies, Lloyd and McRobbie (2003) noted this within-school difference. At one regional primary school (here to be called School A), all students were "taught computers" by a teacher aide following a rigid scope and sequence plan of isolated operational skills devised by the school's Year 7 teacher. Few classroom teachers in School A engaged their students with any experience other than this although one, here to be referred to as Teacher A, was doing so. Her students were asked to present an argument for the local council to reduce the speed limit on the major road running in front of the school. They tallied data and then manipulated it on an *Excel*® spreadsheet to respond to the given information problem. The completed presentations included statistical data and digital photographs as well as the students' conclusions and recommendations. This use of ICT in Teacher A's class is one which mirrors real world applications and integrates its operational skills rather than foregrounds them. This activity was a rare experience for the students at School A. There was no transposition paradox in this activity and ICT was central to its enactment. Students in Teacher A's class were learning both *with* and *through* the technology.

Within the same study, (Lloyd & McRobbie, 2003) a rural primary school of a similar size (here to be called School B) was also observed. The school's ICT co-ordinator (also a Year 7 teacher) was busily encouraging teachers to adopt ICT in meaningful ways but there was one teacher (Teacher B1) whose own limited understanding of ICT meant that all his students did was word processing under the supervision of a teacher aide. The Maslow aphorism that "if all you have is a hammer, then the world looks like a nail" was enacted in this teacher's "integration" of ICT. All that B1's students did were typing exercises. This does present as a transposition paradox because it is a transcription task and could be described as learning *about* the technology. The disassociation from students' own classwork meant that the ICT experience was isolated and fractured.

In an adjacent classroom, Teacher B2 was using ICT in a way which was more than integrative in that it changed typical power structures between teachers and students allowing

students the opportunity to manage their own learning. This was characteristic of Type D ICT use (see Downes et al., 2001). Teacher B2 had developed a cross-curricular unit of work for his upper primary school class on Antarctica. A unit overview was developed in *Inspiration*® making use of its hyperlink functionality to turn the created concept map into an interactive index with direct links to support documents, presentations and relevant websites. All support files and resources could be easily updated and edited in response to changing student profiles and availability of resources without altering the fundamental structure of the overview. The files were posted to the school network where they could be accessed by both staff and students with the latter using the digital resource as a flexible management tool and activity guide. This action involved students metacognitively in the structure and direction of their learning and students were observed engaged in this proactive activities. The role of the teacher had been redefined in this classroom as students moved between off- and on-computer tasks and between collaborative and independent activity. The suite of files also had a role in the management of curriculum within the school, particularly the mapping of KLA (Key Learning Area) outcomes with the Queensland Studies Authority (QSA) syllabuses. This activity shares the same characteristics as Teacher A's spreadsheet task but goes a step further to transformation in the change of power structures from teacher to student.

Schools A and B were both within the Queensland state system, Education Queensland and therefore could be presumed to be enacting the same policies in regard to the role of ICT in teaching and learning. What was noted, however, was a lack of shared purpose between the schools, and more problematically for those who wish to measure integration, within the schools. Holding the "school" as the base measure can only valid if cases within a school are considered as discrete entities.

In considering the school's infrastructure (as in the Scaplen (1999) study), the experiences of Teachers B1 and B2 are illustrative of the fact that, while both had parallel and equal access to the facilities of School B, their use and integration were markedly different. Causality between integration and access cannot be sustained, neither can a link be established between software selection and pedagogical outcomes as Teacher A had used software from the *Microsoft Office* ® suite but had done so in a creative and applied way. Superficially using a business or productivity tool could have been seen as being a poor or limiting choice of software to engage students in meaningful learning. The observed reality differed from this simplistic causality. Similarly the Antarctic learning environment established in Teacher B2's class could be simplistically described as self-paced computer-centred learning. Coding from questionnaire responses may well lose the intent and enactment of the activity and the perceived centrality of the technology to the task.

The key problem is therefore identifying what is to be measured and how it is to be done, particularly, what is to be the base unit of measure and which dimensions of integration are deemed to be critical. A novel approach to this can be seen in a recent Canadian study (Conference Board of Canada, 2002). This study concluded with the design of a framework for measuring ICT integration which views "connectivity and ICT integration as a value chain, moving from ***Inputs*** to ***Impacts***" (p. 8). This can be seen diagrammatically in Figure 1.

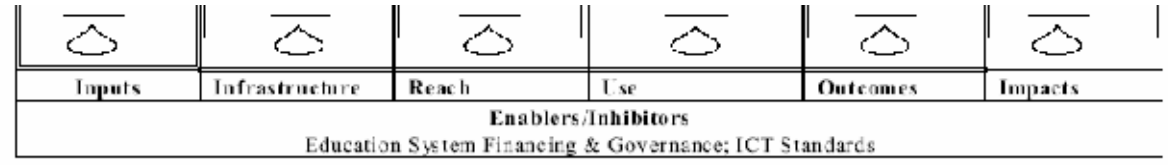

Figure 1: Connectivity and ICT integration framework with describing elements (Conference Board of Canada, 2002).

Each of the seven categories (namely, inputs, infrastructure, reach, use, outcomes and impacts) is affected by enablers and inhibitors. Each feeds into the next with obvious links and interdependencies between the categories for measurement. This is arguably a mechanistic model but it does consider interactions between dimensions and is closer to a mapping of complexity than possible through a simple survey.

Measure and models

It is self-evident to suggest that how something is understood and defined and when and where it is used determines how it should be measured. The way that ICT integration is currently being measured is premised on these notions. A rethinking of the measurement of ICT integration needs a parallel rethinking of what the term means and arguably a clearer understanding of the role and level of mediation of the technology itself. Similarly a rethinking of what "technology" means and how it is used reflexively affects its measurement. It is of interest that the previously cited email list respondent who was incensed (and nauseated) by the use of the term "ICT integration" went on at length to describe technology as a tool. He drew an analogy of other "tools" (such as a javelin in Physical Education, or food processor in Home Economics) and how there is never any discussion of these being "integrated." His defining of "integration" comes causally from his conceptual understanding of what a computer is and how it is used. This enactment of belief was also seen in Teacher B1's approach to ICT experiences which were restricted to using a word processing application because of his conceptual understanding of a computer as a productivity tool.

This identification of belief enactment presents us with another problem in measuring ICT integration. Reimann and Goodyear (2004) noted the importance of "confront[ing] the issue that technology, and what we aim to do with it, are changing rapidly; understanding the relations between learning, pedagogy and ICT needs a firm grip on what is stable and what is in flux" (p. 2). Because our demands are changing, then so too is what defines "integration." Measuring the extent students learn "about" technology would be a measure for an older arguably simpler time before ICT went cross-curricular and schools were connected to the Internet and had access to inexpensive robust peripheral devices. The changing use of the *about*, *with*, *from*, and *through* descriptors is evidence of the changing demands and, equally, of changing capacities.

A key principle of developing effective and current measures and models of ICT integration is that new technologies are ecological in that they change the whole environment in ways that other technologies (such as a javelin or food processor) do not. Lankshear et al. (1997) argued that new technologies change the "social practices within which they are used, with the result of changing the way people talk and think about them" (p. 48). An acceptance of this key principle translates into a model which takes a holistic view of a learning environment as opposed to focussing on specific features (such as those considered in the Scaplen (1999) study).

The measurement of ICT integration could arguably be simply quantified from 0 to 100 percent, with "0" being where integration is non-existent or revealing "inaction" and "100" being a full seamless embedding of ICT into class activities. Fluck (2003) argued that integration relates to the way in which ICT is incorporated into student learning and can, interestingly, be treated separately from its consequences. This view is validated where "integration" is achieved to the extent where it is not visible. Philosophically, full ICT integration could not be measured as 100% cannot also be 0.

A further instance of 100% integration could be where CAI (computer-assisted instruction) learning experiences are used and where there is a 1:1 student:computer ratio and that all "learning" is programmed. Integration measures do not usually encompass these environments as they are uncommon in classroom situations.

Measurement could be (as in Conference Board of Canada, 2002) based on a profile of general characteristics or dimensions. The advantage of more complex measurement is that it is more likely to represent the complex nature of integration as opposed to simplistic measures based solely on teacher perceptions, skills or attitudes. The disadvantage is that they are based on unfounded assumptions particularly in determining causality between such entities as access and pedagogy. This paper has contended five issues of concern in the measurement of ICT integration. These are (a) the transposition paradox where old learning is moved to new media, (b) the reliance on/centrality of technology on the learning experience, (c) the relationship between student, learning and the technology, that is, is the learning occurring about, with, from or through the technology, (d) determining the base unit of measure, for example, teacher (which may mask complexity) or school (which may not allow for differences both within and between schools because of enacted belief dominating stated policy and goals), and (e) potentially erroneous causal connections. What can be stated unequivocally is that the measurement of integration is problematic.

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