

Quality Pedagogy and Effective Learning with Information and Communications Technologies (ICT): a review of the literature.

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BRIEF: To provide a study to the Department of Education on the:

1. characteristics of effective learning and quality pedagogy as they relate to ICT integration; and
2. stages of progress by teachers as they move towards quality pedagogy as it relates to ICT integration .

Companion Document

Based on this review of the literature a framework for describing and monitoring the progression of teachers in their integration of ICT in learning and teaching processes was developed.

A Teacher Professional ICT Attributes Framework – Outcomes, Guidelines, Equipment and Processes

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December 20002

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Published by Specialist Educational Services

Perth, Western Australia

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Introduction

The use of Information and Communications Technologies (ICT) in schools is taken very seriously by governments and education systems around the world. Australia, like many other countries, is investing heavily (estimated \$AUD200 million annually) in the education system to raise the ICT skills of Australians and move towards the information society (Trinitas, 2000). This is testament to the importance being placed on education and training in the use of ICTs and the setting of high priorities to improve learning outcomes to prepare young people for the information economy of the 21st century.

As educational institutions move towards the mainstream use of ICT in teaching and learning there appear to be some critical steps and vital ingredients needed for the successful infusion of ICT into educational environments. Although standalone computers have been in most schools for more than two decades now, networked ICT is relatively new for many schools as they continue to grapple with how to use ICT to enhance teaching and learning environments.

Since the development of the first computers many educators (e.g. Bork, 1980; Carnegie Commission on Higher Education, 1977; Papert, 1980) have argued that computers should be used to support learning. These arguments have amplified as computers have evolved into the powerful relatively low-cost technology available today. However, there is considerable debate over how computers should be used in schools (Riel, 1998). Australia is recognised internationally as an early leader in the adoption of, and research into, the use of computers in schools.

This review focuses on the use of computer systems in schools by students and teachers to support the processes of learning and teaching. It will aim to describe the ways in which teachers could and/or should facilitate student use of computer systems and how they can progress. In order to do this the review will explain a conceptual framework within which to address these concerns, and analyse and synthesise current research in the area to suggest models for teacher engagement with the integration of ICT into learning and teaching.

The review begins with a background to the use of computers in schools, touching on a rationale for computers in schools, followed by a review of some of the models that have been developed over the past 15 years. This review is set within the Australian and Western Australian contexts. From here a discussion is presented of the level to which teachers can facilitate computer support for learning in terms of the learning environment and factors affecting this. This leads into a discussion of the professional development needs of teachers for the progression of using ICT in learning and teaching. This then provides the background for the development of a framework as outlined in the companion document, *A Teacher Professional ICT Attributes Framework – Outcomes, Guidelines, Equipment and Processes*.

The assumed context for the review is the set of conditions currently prevailing in, or planned for, Western Australian government schools. Principally, the context is dominated by the implementation of the Western Australian Curriculum Framework that sets up an outcomes-based approach to education within a developmental-constructivist view of learning. Fundamental to an outcomes focus in education is a shift in focus from an emphasis on teaching and holding educators accountable for what they teach, to an emphasis on learning and holding educators accountable for what and how students learn. In other words, in the past teachers focused on looking after the teaching and tended to assume that if they did that correctly, it was the students' responsibility to take care of their learning. However, in an outcomes approach, teachers are responsible for ensuring all students learn — and make progress. This provides a background within which to consider the use of ICT by students and teachers.

Schools, Learning and Computers

Any discussion about the use of computer systems in schools is built upon understandings of the link between schools, learning and computer technology. When the potential use of computers in schools was first mooted, the predominant conception was that students would be 'taught' by computers (discussed by Mevarech & Light, 1992). In a sense it was considered that the computer would 'take over' the teacher's job in much the same way as a robot computer may take over a welder's job. Collis (1989) refers to this as "a rather grim image" where "a small child sits alone with a computer" (p. 11).

During the 1980s, computers became more affordable to schools, permitting a rapid decrease in student-to-computer ratios. While tutorial and D&P software continued to be developed (Chambers &

Sprecher, 1984), a range of other educational software was developed that was not based on the premise of teacher replacement, for example, simulation software, modelling, and tool software. However, the major argument used to support the introduction of greater amounts of computer hardware into schools concerned the perceived need to increase the level of computer literacy of students (Downes, Perry, & Sherwood, 1995).

Towards the end of the 1980s and into the 1990s, while the computer literacy rationale still remained (Hannafin & Savenye, 1993; Hussein, 1996), the major rationale for having computers in schools was more concerned with the need to use computers to improve student learning. Broadly speaking, computer literacy is a component of Technology Education, which is distinct from using technologies such as computer systems to support learning and teaching processes. The latter is generally referred to as educational technology; and is applied to a wide range of technologies such as blackboards and chalk, pencils, books, and slide-rules to television, facsimiles, and computers. This review will focus on the use of computer systems as educational technologies.

Since the beginning of the 1990s, educators have been particularly concerned that very little of the potential of computers to support learning in schools seems to have been realised, despite a sufficient installed base of computers. Numerous studies (Becker, Ravitz, & Wong, 1999; Plomp & Pelgrum, 1992) have shown that few teachers facilitate student use of computers. One of the reasons often given for this anomaly is that the technology is not sufficiently accessible, particularly if students have to go to a special room to gain access.

While it is assumed in this review that computer support for learning is essential, some discussion of the rationale is required as a background to later discussions concerning models for the use of computing systems to support learning and teaching.

The rationale for using computers in schools

Technology is developed to solve problems associated with human need. If there is no problem to solve, the technology is not developed and/or not adopted. Applying this principle to educational technology would mean that educators should create and adopt technologies that address educational problems, of which there are many. Further, a technology will not be adopted by educators where there is no perceived need. Therefore, when discussing applications of computer technology to education the question must always be asked, "What educational problem(s) needs to be addressed?" This question needs to be asked at all levels of decision-making, from the teacher planning a programme, to a school administrator purchasing hardware and software, to an educational system officer developing policy and strategic plans.

At the teacher level the question becomes: "Am I satisfied with the educational opportunities I am able to offer students in school classrooms?" While teachers should never be completely satisfied, and they will always strive to do better, the question really is whether what they provide adequately develops the potential of the students and adequately prepares them for a productive life in society. Many educators (e.g. National Centre for Vocational Education Research, 2002) and educational commentators (e.g. Murdoch, 2001) believe that what is offered in school classrooms in developed countries such as Australia, is hopelessly inadequate to match the needs of our society and the needs of individual students. Schank and Cleary (1995, p. ix) put this succinctly when they state, "Today's schools are organized around yesterday's ideas, yesterday's needs, and yesterday's resources (and they weren't even doing very well yesterday)." An increasing number of educators (e.g. Schlechty, 1997) are sure that part of the solution is to provide better technology support for learning environments. Schank and Cleary (1995) argue that we know enough about learning to support it with computer systems, using software that allows students to experience activities, at school, that have been impossible or difficult, and thus avoided in the past.

At the school and system levels the educational-problem question becomes whether the resources available to the school are being most efficiently employed to provide the most effective educational opportunities for students. It becomes much more a question of productivity, a balance between inputs (resources) and outputs (learning outcomes). Investing in computer technology means reducing investment in other resources (e.g., books, teachers, buildings). Will using computers provide better learning outcomes than the equivalent investment in those other resources? If so, what level of investment in computers compared with other resources will provide the optimum output? Very few educators and educational commentators would advocate no investment in computers, even if only using a computer literacy rationale. A few advocate an investment that supports almost all education being conducted electronically, particularly online, often referred to as e-learning (e.g. Bonk, 2001). Most are somewhere between these extremes.

At the political level the question comes down to whether an adequate investment is being made in education when compared with other services that our community requires. Providing computer technologies for schools has usually involved increases in investment in education that must be justified to the community, and that is usually done by quoting student:computer ratios. While research tends to have been somewhat inconclusive, increasingly studies are showing investments in computer technologies result in significant improvements in learning, however it is measured. For example, a study in West Virginia (Mann, Shakeshaft, Becker, & Kottkamp, 1999) found an average effect size of over 0.4 standard deviations, which was claimed to be more cost-effective than a reduction in class sizes. Education is central to the long-term well-being of our society and individuals, teachers and students need all the support they can get; hence the need to consider the potential of all available technologies.

This discussion will assume that educators should create and adopt technologies that address educational problems and/or improve productivity. The rationale for the use of a technology to support learning should arise from dissatisfaction with the educational opportunities offered to learners and a striving to do better. Warnings have been made for decades about falling into the trap of what Papert (1987) calls 'technocentric thinking'. Most educators would claim not to be technocentric; however, when discussing the use of computers in schools there is always the danger that the focus will be on the technology, particularly the hardware. When making decisions about the use of computers in schools, particularly budgetary decisions, there is a tendency to start with a consideration of the hardware, then the software and perhaps consider the users and learning last and least. Rather, most educators (e.g. Fullan, 1995; Means & Olson, 1994; Papert, 1987) would agree that all discussions and decisions should be prefaced with a consideration of learning theory and the learning environment; for, indeed, educational technologies are only a mediator in learning processes, and only one of many.

Rieber and Welliver (1989) define educational technology as a process involving, "a systematic approach to identifying instructional problems and then designing, developing, implementing, and evaluating instructional solutions" (p. 22). They argue that, "In order for the full potential of educational technology to be realised, it must be viewed more as a process rather than just the implementation of educational tools" (p. 22). Thus the educational technology process begins with the identification of an educational problem not with the existence of a technology. In other words, we need to start with the well-supported beliefs we have about learning and make sure that any solutions are consistent with them. There is no doubt that the most commonly held set of beliefs about learning, well supported by research, are those bearing the label of constructivism. As the Committee on Developments in the Science of Learning (2000, p. 10) put it, "the contemporary view of learning is that people construct new knowledge and understandings based on what they already know and believe". Further, there is an assumption that learning occurs within a physical and psycho-social environment usually labelled as the learning environment (Fraser, 1994). These were not the commonly held views of learning when current schooling structures were developed over a century ago. If a rationale for computing is to be grounded in an understanding of the nature of learning and teaching, this must begin with an examination of learning environments and the key precepts of constructivism.

Learning environments

Learning environments in schools typically involve one or more adult teachers connected with a number of students, usually in well defined physical settings. These people interact and form a variety of relationships, creating what Salomon (1994) calls "a system of interrelated factors that jointly affect learning in interaction with (but separately from) relevant individual and cultural differences" (p. 80). This is what Wubbels, Brekelmans, and Hooymayers (1991) term the "relationship dimension" in learning environments at school. The learning environment has a physical as well as a relationship dimension. Physically it may be in a room, full of particular furniture and equipment. Curriculum materials such as books and videotapes may also be present. The curriculum also has a place in the relationship dimension of the environment in that the students and teacher(s) are focused on certain processes and content in the curriculum and have a relationship with that curriculum and the methodologies that are associated with conveying the curriculum. Students and teachers may have very different relationships with different components of the curriculum.

The place of computers in learning for the majority of children is most likely to occur in the classroom and, for an increasing number, at home. Most experts in the field of educational computing (e.g. Lynch, 1990; Olson, 1988; Rieber, 1994) would characterise computers as interactive and thus admit them a place within the relationship structures of the classroom learning environment, not just the physical environment. The majority of school classroom learning environments that incorporate computers could thus be depicted using the model in Figure 1.

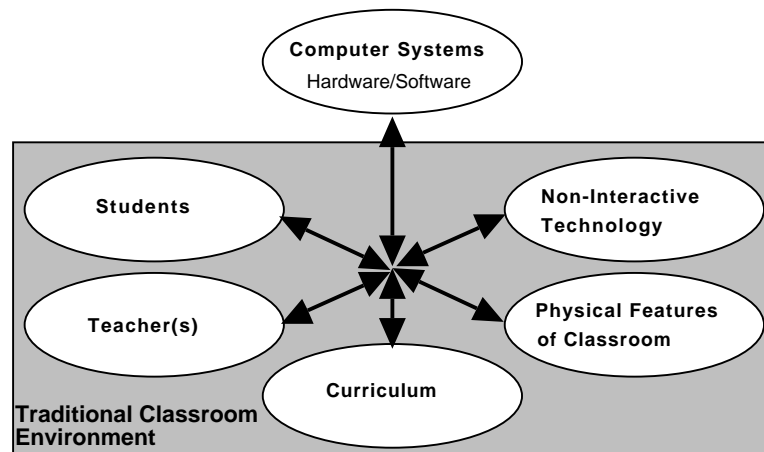


Figure 1. A model to consider the relationship of computer systems to other elements of the learning environment.

The learning environment provides a structure within which to describe the setting in schools within which learning is organised and the roles of the teacher and students occur. This is based on the relationships between the types of components comprising the environment. However, it does not describe the reasons or purpose behind the construction of any particular environment. This is dependent on the beliefs and actions of those responsible for setting up the environment, particularly the underlying pedagogical philosophy of the teacher. There is little doubt that the pedagogical philosophy to which most 'Western' educational leaders and researchers subscribe is that of constructivism.

Learning Theory - Constructivism

Almost all those who advocate major reforms of schooling, particularly through the use of computers, have the view that learning needs to be more informed by constructivism (e.g. Clouse & Nelson, 2000). Often arguments for school reform involve constructivist concepts such as the need for students to develop higher order thinking skills and the failure of current schooling methodologies to provide the opportunity (Campione, Brown, & Jay, 1990; Loader & Nevile, 1991). In the extreme, the technologies of the information age are perceived to be an irresistible force on education (Mehlinger, 1996). Within the context of linking the use of computer technologies with reforming schooling,

Constructivism has its roots in the psychology-based traditions going back to Dewey (1966), Bruner (1962; 1966), Piaget (1970) and Vygotsky (1978). However, more recently this is supported by biological science-based theory in neuroscience. There is a good discussion of this convergence of support for constructivism in the report by the Committee on Developments in the Science of Learning (2000).

What is meant by constructivism? There is no single definition of constructivism (Perkins, 1992; von Glasersfeld, 1992), and the term is often not defined explicitly by the user of the term. However, there is a common element in the belief that knowledge is constructed out of personal sets of meanings or conceptual frameworks based on experiences encountered in relevant environments. People interact with their environment and as a result develop conceptual frameworks to explain these interactions and assist in negotiating future interactions. As Perkins (1992) puts it,

Central to the vision of constructivism is the notion of the organism as "active" - not just responding to stimuli, as in the behaviourist rubric, but engaging, grappling, and seeking to make sense of things (p. 49).

Neurologically, this is the result of complex sets of connections being formed between neurons, these connections being called dendrites (Committee on Developments in the Science of Learning, 2000).

Pines and West (1986) developed what they call a "sources-of-knowledge" model of learning based on constructivism in which they discriminated between two sources of knowledge for school children: firstly, knowledge spontaneously acquired from interactions with the environment; and secondly, knowledge acquired formally through the intervention of school (refer to Figure 2). These two sources of knowledge are represented as vines in a metaphor based on the writings of Vygotsky (1978). The

former source originates from the learner and thus is known as the upward growing vine. The latter source is formal knowledge imposed on students and therefore is known as the downward growing vine. Therefore, education in schools is concerned with the meeting of these vines that Pines and West (1986) define as four possible paradigms (congruent, conflict, formal-symbolic, and spontaneous), based largely on the relative strengths of the existing and imposed frameworks and the degree to which the frameworks are different.

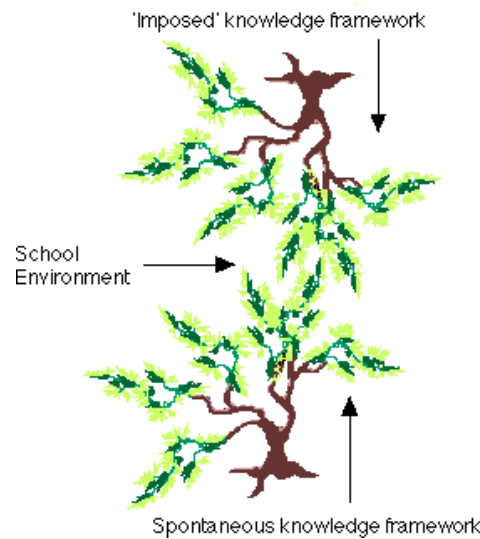


Figure 2 Schematic of Pines and West 'vines' representing the knowledge frameworks imposed by the curriculum and that spontaneously developed by the individual.

Knowledge Frameworks

Clearly then both the knowledge frameworks of students (prior knowledge) and of the knowledge domains relevant to the learning activities must be considered in the integration of ICT. Many educators have argued that the appropriate use of ICT by students can assist teachers in determining and catering for the prior knowledge of students. Further, it is usually also argued that ICT can assist students in engaging cognitively to a greater depth with knowledge domains. That is students are supported in employing the full range of thinking skills within authentic contexts. This is often discussed in terms of cognitive taxonomies such as that provided by Bloom (1964).

Pedagogy and Constructivism

There is often the misguided belief among teachers that constructivism means that all learning must be entirely by discovery and that the teacher and curriculum materials have no place. Perkins (1992) describes two constructivist positions on teaching/learning paradigms as *without the information given* (WIG) constructivism and *beyond the information given* (BIG) constructivism. It is advocated that a blend of both approaches are employed. DeCorte (1990) discusses this balance of approaches in the context of using computers in schools,

a powerful computer learning environment is characterized by a good balance between discovery learning and personal exploration on one hand, and systematic instruction and guidance on the other, always taking into account the individual differences in abilities, needs, and motivation between students (p. 74).

It is important to avoid equating particular sets of teaching strategies with constructivism. One teacher may choose to employ certain strategies in a manner consistent with her constructivist notions, while another may employ quite different strategies in a manner that is equally consistent with his constructivist notions.

A common misconception regarding "constructivist" theories of knowledge is that teachers should never tell students anything directly but, instead, should always allow them to construct knowledge themselves. This perspective confuses a theory of pedagogy (teaching) with a theory of knowledge, irrespective of how one is taught – even listening to a lecture involves active attempts to construct new knowledge (Committee on Developments in the Science of Learning, 2000, p. 11).

The educator who believes in constructivism should be concerned with personal conceptual frameworks, prior knowledge, students' understandings, the relationship of formal knowledge to spontaneous frameworks, and the attitude of the learner to formal knowledge (Osborne & Wittrock, 1985; von Glasersfeld, 1991).

Vosniadou (1994) argues that a belief in constructivism will determine the type of computer software used in classrooms and the manner in which computer-use is integrated with the curriculum and implemented into the classroom. The fundamental focus for a constructivist starts with the individual student within the context of the environment in which that student is placed. This focus on the student rather than the instruction, typically referred to as student-centred learning, underpins the role and tasks of the teacher.

Implicit in an outcomes approach is student-centredness. A student-centred approach requires a shift from the teacher as director of learning to facilitator of the learner's direction and creator of learning opportunities (Albon & Trinidad, 2002). This requires a significant cultural change about what school education is and how it should be delivered (Curriculum Council of Western Australia, 1998) often using technology in the process of teaching and learning.

Student-centred learning acknowledges the learner's participation in the learning experience, while learner-centred, following the philosophy espoused by John Dewey in 1910 (Woolfolk, 2000), refers to strategies which put the learner in control of constructing their own learning. A learner-centred approach acknowledges the role of pace, repetition, learning styles, motivation, self-regulation and responsibility to learn. Assessment in a learner-centred approach is considered an aspect of learning. This is in contrast to the teacher-directed, traditional approach in which assessment may not be central to the learning. The learning emphasis is now on knowledge construction and inquiry with the technology becoming the tool for communication, collaboration, information access and expression. The table below (Table 1) presents the changes that may occur when a teacher moves from a traditional (instruction) mode to a more extended (knowledge construction) mode.

Table 1
Traditional (instruction) vs. Extended (knowledge construction)

	Traditional (instruction)	Extended (knowledge construction)
Activity	Teacher-centered and didactic	Learner-centered and interactive
Teacher role	Fact teller and expert	Collaborator and sometimes learner
Student role	Listener and learner	Collaborator and sometimes expert
Learning emphasis	Facts and replication	Relationships and inquiry
Concept of knowledge	Accumulation	Transformation
Demonstration of success	Quantity	Quality
Assessment	Norm-referenced and multiple guess	Criterion-referenced and performance portfolios
Technology use	Seat work	Communication, collaboration, information access, and expression

Source: *A Report on 10 Years of ACOT Research (p13) learning—from instruction to knowledge construction. (ACOT, 1995, p13)*

Once again, a learner-centred approach does not imply a particular set of strategies for a teacher and therefore does not imply a particular set of applications of ICT to the learning environment. A report from the Apple Classrooms of Tomorrow project (ACOT, 1995, p14) explains that,

... teachers need to balance curriculum-based instruction with opportunities for students to use an inquiry-based, collaborative approach to solve meaningful problems. Problem-based learning lets students build on their own knowledge and incorporate new information with what they have already learned and when technology is available to students, it not only opens up opportunities to solve problems, it also provides additional tools for communication and collaboration.

Integrating ICT into classrooms enables teachers to shift their pedagogical approach towards a balance between teacher-centred instruction and learner-centred, collaborative problem solving and critical thinking. This can be done through projects using

- interactive computer-based learning resources;

- linking with networked communities of peers and experts;
- online collaborations in and beyond the classroom and online information access going beyond the textbook.

In education we are faced with the daunting task of making significant change in teaching and learning to prepare our students for the future by creating and supporting the appropriate learning environments.

Constructivist Learning Environments

In 2000 the U.S.A. Committee on Developments in the Science of Learning addressed the issue of what should be considered in developing learning environments in their report *How People Learn: Brain, Mind, Experience, and School*. They defined “four interrelated attributes of learning environments that need cultivation” (p.23).

1. Schools and classrooms must be **learner centred**. (p. 23)
2. To provide a **knowledge-centred** classroom environment, attention must be given to what is taught (information, subject matter), why it is taught (understanding), and what competence or mastery looks like (p. 24).
3. Formative assessments – ongoing assessments designed to make students’ thinking visible to both teachers and students are essential. They permit the teacher to grasp the students’ preconceptions, understand where the students are in the “developmental corridor” from informal to formal thinking, and design instruction accordingly. In the **assessment-centred** classroom environment, formative assessments help both teachers and students monitor progress (p. 24).
4. Learning is influenced in fundamental ways by the context in which it takes place. A **community-centred** approach requires the development of norms for the classroom and school, as well as connections to the outside world, that support core learning values (p. 25).

This structure provides an image of the ideal and thereby throws some challenges at education systems. Some of these challenges may be met with ICT support.

ICT Integration in Learning Environments

Almost all of those who advocate major reforms of schooling, particularly through the use of computers, have the view that learning needs to be more informed by constructivism (e.g. Clouse & Nelson, 2000). A critical component is the concept of proximal learning, based on the work of Vygotsky (1978), that posits that learning takes place by the learner completing tasks for which support (scaffolding) is initially required. This support may include a tutor, peer or a technology such as the applications of computers. This has led to the use the term computer supported learning. Computer supported learning environments are those in which computers are used to either maintain a learning environment or used to support the student learner in this Vygotskian sense (DeCorte, 1990). Therefore the technology is used to help create the types of learning environments and the types of support for learning that are known to be ideal that Glickman (1991) argues have been ignored or failed to be implement widely in the past.

The aim is to create learning environments centred on students as learners and a belief that they learn more from what they do and think about rather than from what they are told. If the aim is to offer new learning opportunities, or to improve the way in which current learning activities are implemented, then the overall effectiveness of learning environments and episodes is of paramount concern, not whether they are more effective with or without computers. It is important that the ever changing nature of computer-based technology not overshadow the enduring nature of learning and the solid and ever increasing base of knowledge about learning. This knowledge is not superseded by new technologies; rather, it can inform the use of new technologies when applied to learning. Therefore, in implementing computer support for learning it is necessary to start by deciding what a student, teacher or school wants to achieve. To achieve these outcomes, teachers can then rely on long traditions of educational theory, their own experience and knowledge of the educational situation (e.g., student attributes) to make decisions about what the learning environment should look like, and what inputs into the learning process are required. Finally, teachers can identify what problems are associated with providing these environments and inputs and tailor computer and other support to provide solutions. In essence, the judgement of teachers and their support structures are relied upon to choose appropriate strategies. This approach ends with decisions concerning computer support rather than starting with such decisions (c.f. Campione et al., 1990).

The Committee on Developments in the Science of Learning (2000) suggested five ways to use ICT to establish and sustain effective learning environments:

1. Real world problems
2. Scaffolding
3. Feedback, reflection and guidance
4. Local and global communities
5. Extending teacher learning

David Jonassen's "Designing a Constructivist Learning Environment" web-site has a section on Tools (<http://tiger.coe.missouri.edu/~jonassen/courses/CLE/>) where five ICT tool categories for designing constructivist learning environments are outlined.

1. Problem/Task Representation Tools
2. Knowledge Modeling Tools
3. Performance Support Tools
4. Information Gathering Tools
5. Conversation and Collaboration Tools

These provide theoretical frameworks to implement the use of computers to support high quality learning environments.

If an educator believes that only the students themselves can construct their own knowledge, then the role of the educator is to provide an environment in which the learning activities support the role of the student as a learner. The environment becomes one that is learner-centred or learner-focused. The student as the learner is one who is involved in constructing their own meaning through the higher level thinking processes of analysing, synthesising and evaluating. Technology such as ICT can be considered integral to the process of identifying, gathering and recording students' own learning, and building the community of learners.

An elevation of the importance of quality teaching and learning in education, exemplifies the need for engaged, meaningful, collaborative learning involving challenging and real-life tasks. As the Curriculum Council's (1999) *Post Compulsory Education Review Discussion Paper* states

"citizens of the twenty-first century will require knowledge and skills that enable them to be creative and enterprising. Initiative, risk-taking, lateral thinking and resourcefulness will be vital to success. People will need to be flexible and adaptive in a society that is changing economically and socially. They will need to be technologically competent, capable of using the opportunities of the digital world and self-managing of careers that may change many times. As life-long learners, they will need to continue to access education and training" (p.1).

ICT can indeed empower the educator with new solutions to learning but there is no single solution to be gleaned from all this. Not only must you consider the ICT, you must consider in the solution a number of factors, including the nature of teaching, student approaches to learning and the use of technology and access to information and resources. In addition, past methods cannot solely be relied on to assess learning as they are incongruent with current learning processes. Future methods should assess the effectiveness of learning environments and learning opportunities to produce graduates with the necessary attributes for work place employment.

Learning Communities

The constructivist learning environment is not one-sided; instead it admits a range of learning by all participants, including the teachers. This suggests that schools need to consider factors like pedagogical practice and the learning assessment structures (Newmann & Weylage, 1995; Wenger, 1998) as they strive to build what Newmann calls Professional Learning Communities. This simultaneous focus on assessing student learning, the school-wide community and teacher pedagogy is expressed in Figure 3, from Newmann (1995).



Figure 3: Critical factors for a Learning Community

An obvious extension of this conception of the importance of community is to include the role of ICT as a structural element in their formation and development. After all email is a significant contributor and increasingly the literature about learning communities shows that ICT in classrooms is a common tool to increase the focus on authentic student activity (Newmann & associates, 1996). This suggests an elaboration of Figure 3 to represent the three key principles of the ACOT research (Sandholtz et al., 1997). Figure 4 illustrates the structural elements comprising a learning community, as exemplified by the key objectives of the ACOT project for teacher development (Sandholtz, 1997).

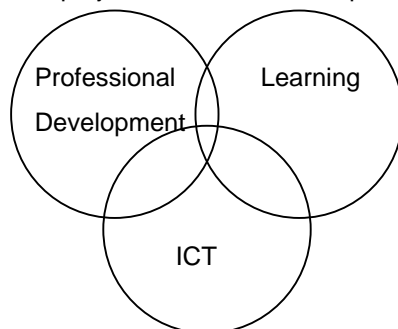


Figure 4 The Structural Components of a Learning Community.

These characteristics about learning communities and their value in stimulating the quality of learning in schools is a significant component in the search for helpful models of teacher development in schools. Before educators can begin to develop integration skills they must realise and understand how the integration of ICT can enhance the teaching and learning environment. Technologies capable of providing interactivity, learner control and student engagement can improve instruction. For learning to take place, learners must be engaged in the process of learning. One way to engage learners is to motivate them through authentic learning experiences. Authentic learning experiences are instructional activities that demonstrate real-life connections by associating the concept of being taught with a real-life activity or event while promoting active learning.

In taking the community of learners model further, the Mediated Learning Approach (MLA) (Figure 5), illustrates the educator as one who brings their expertise, a syllabus or content, objectives and educational technology support to the learning environment but recognises that the educator mediates the learning, not determines the learning. MLA recognises the learning is learner-focussed where the learner brings prior knowledge, attitudes, skills and a variety of approaches to their own learning. Outcomes/attributes provide the vision of what the learner should achieve, that of thinking critically, analysing information and problem solving. Here the student is seen as actively and meaningfully engaged in their own learning which is embedded in a social and interactive environment (Albon & Trinidad, 2002).

The potential of ICT in learning environments can support dialogue, enhance interaction and help students to share and revise ideas. In other words, support a learning community. Laurillard (1995) specified these dimensions in her conversational framework for 'learning with technology'. They include discussion (exchanging understandings); adaptation (adapt each others' ideas); interaction (engaged in interaction) and reflection (reflect on experience). In the broader school environment it is instructive to consider the process of building a successful learning community and how ICT can play an important role in this development.

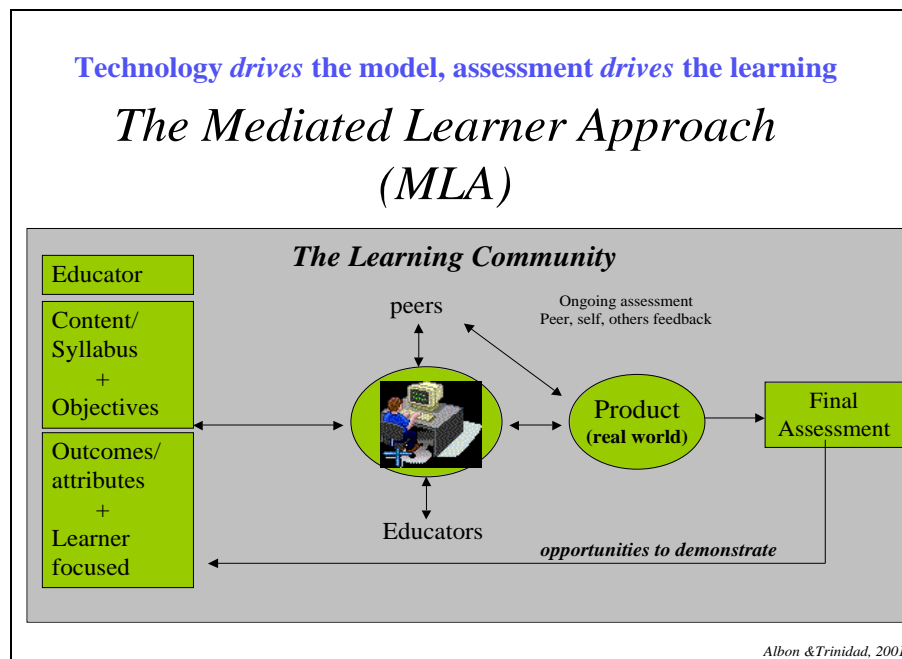


Figure 5 The Mediated Learning Approach

Successful School Improvement and ICT

Newman & Wehlage (1995) argue that the organizational capacity of a school determines its ability to accept and commit to change. Importantly this capacity “is enhanced when schools are shaped into professional communities” (p. 30). In the same way that high quality student learning is stimulated by the principles of authentic assessment, so a school’s organizational capacity is grown by the vision of a school as a professional community. The relevance of this issue to schools wrestling with the processes of change inherent in ICT uptake is predictable. Schools that regard themselves as professional learning communities have a number of advantages, particularly that they enhance student achievement. Specifically school-wide teacher professional communities affect the levels of authentic classroom pedagogy, which in turn affects student performance. Newman & Wehlage (1995) also found that they affect the level of social support for student learning, which again affects student performance.

Connecting with the Local Context

The local Western Australian context is dominated by the implementation of the outcomes-based Curriculum Framework (CF). It would be hoped that the CF would be well aligned with contemporary educational thinking and research. Towards the beginning of the CF document there is a discussion of the assumed principles of learning, teaching and assessment. There are seven key principles of learning and teaching and five key principles of assessment (pp. 33-39). These clearly are aligned with the attributes of a constructivist learning environment as discussed earlier in this review. The table below explains this alignment.

Table 2
Key Principles of Learning, Teaching and Assessment

Key Principle	Explanation	Constructivist Attribute
Opportunity to learn	Learning experiences should enable students to observe and practise the actual processes, products, skills and values which are expected of them.	Learner Knowledge Assessment Community
Connection and challenge	Learning experiences should connect with students’ existing knowledge, skills and values while extending and challenging their current ways of thinking and acting.	Learner Knowledge
Action and reflection	Learning experiences should be meaningful and encourage both action and reflection on the part of the learner.	Learner

		Knowledge Assessment
Motivation and purpose	Learning experiences should be motivating and their purpose clear to the student.	Learner Knowledge
Inclusivity and difference	Learning experiences should respect and accommodate differences between learners.	Learner Community
Independence and collaboration	Learning experiences should encourage students to learn both independently and from and with others.	Learner Community
Supportive environment	The school and classroom setting should be safe and conducive to effective learning.	Learner Community
A1. Valid	Assessment should provide valid information on the actual ideas, processes, products and values expected of students.	Knowledge Assessment
A2. Educative	Assessment should make a positive contribution to student learning.	Learner Assessment
A3. Explicit	Assessment criteria should be explicit so that the basis for judgements is clear and public.	Assessment Community
A4. Fair	Assessment should be demonstrably fair to all students and not discriminate on grounds that are irrelevant to the achievement of the outcome.	Learner Assessment
A5. Comprehensive	Judgements on student progress should be based on multiple kinds and sources of evidence.	Knowledge Assessment

Further, in the document, An Introduction to the Curriculum Framework (1998, p. 9) by the Curriculum Council of Western Australia, six statements are provided as evidence to guide teachers in implementing “An outcomes focus in relation to the curriculum Framework” (p. 9). These evidence guides also align well with the attributes of a constructivist learning environment as shown in the table below.

Table 3**Evidence Guides aligning with Attributes of a Constructivist Learning Environment**

Evidence that a teacher is implementing an outcomes focus	Attribute of Constructivist Environment
Plan and teach to ensure that all students achieve the outcomes	Learner centred Knowledge centred
Incorporate the core shared values in their planning, teaching and monitoring.	Knowledge centred – Assessment centred - Community centred
Adapt and develop curriculum to meet the needs of all students.	Learner centred – Knowledge centred
Make judgements about students' progress in relation to the outcomes	Knowledge centred – Assessment centred
Provide learning opportunities to assist students to see relationships among knowledge, skills and values	Learner centred – Knowledge centred – Community centred
Work collaboratively to achieve integration, breadth and balance in the curriculum.	Knowledge centred – Community centred

There is further evidence of the alignment of the Western Australian government schools context with prevailing international understandings in the teacher support document produced by the Education Department of WA (1999) titled, *Focussing on outcomes: curriculum, assessment and reporting*. The document states that,

In planning for outcomes-focused curriculum provision, teachers, working individually and in groups, need to review: 1. students' achievement; 2. the learning environment; 3. classroom approaches to curriculum provision; 4. pedagogy; and 5. the school plan." (p.11.)

... caters for the developmental needs of students. (p. 12)

... organization and structure of classrooms. (p. 14)

... subject content approach, competencies approach, role performance approach (p.15)

An outcomes focus requires teachers to become more student centred in their approach. (p. 16)

These clearly align with a constructivist learning environment view of the process of learning and teaching.

Models to explain the Integration of ICT into Learning Environments

In the 1990s, several major research efforts, in various countries of the world (e.g. Cicchelli & Baecher, 1990; Collis, 1994; Marcinkiewicz, 1995; Rieber & Welliver, 1989; Sandholtz et al., 1992) began to develop and apply models for investigating the implementation of computers in classrooms. Many of these are based on teachers' concerns about innovations, and are often called concerns-based models.

The Concerns-Based Adoption Model (CBAM)

Most of the concerns-based models evolved from the work of Fuller (1969) on the concerns of teachers as they developed their pedagogical skills. For example, the Concerns-Based Adoption Model (CBAM) (Rutherford, 1977) was developed from Fuller's model in the early 1970s and has been widely applied to the implementation of educational innovations since that time (Hall & Carter, 1995), including in Western Australia (Carter, 1986). The model associated with the ACOT project (Dwyer et al., 1991), the Instructional Transformation model (Rieber & Welliver, 1989), and the PIT models developed in The Netherlands (Collis, 1994) all ultimately are based on Fuller's model. However, the CBAM model has been more fully developed and applied and thus is more often referred to by other models.

In the same way that CBAM is one of a number of models developed from Fuller's work, there are many models currently being developed for use in research with computers in classrooms that have their roots in the CBAM Project from the Southwest Educational Development Laboratory, at the University of Texas (Hall & Hord, 1987; Rutherford, 1977). The CBAM model for implementing and evaluating the adoption of any innovation in education was first published in the mid-1970s (Hall, Loucks, Rutherford, & Newlove, 1975) and has undergone further validation over the last 20 years (Hall & Carter, 1995).

The Model

This model comprises three key dimensions, *Stages of Concern* (SoC), *Levels of Use* (LoU), and *Innovation Configuration* (IC), the first two of which are explanatory and the third diagnostic in nature and scope. The three dimensions each represent a facet of the change process, with SoC and LoU focusing on the implementer while the IC considers the nature of the innovation itself. The SoC and LoU dimensions were developed out of the work of Fuller (Hall & Carter, 1995), but the IC was developed much later. Each dimension has associated with it a designated research method and an instrument to collect and present appropriate data. The CBAM requires the researcher to be immersed within the scene of the innovation and to continually refine judgements associated with the diagnostic dimensions.

The *Stages of Concern* (SoC) describe "how teachers or others perceive an innovation and how they feel about it" (Hall & Hord, 1987, p. 13). It uses a questionnaire with a set of scales to prepare a numerical and graphical picture of the type and strengths of participants' concerns. The sequence of stages with descriptions are provided in Appendix A.

The *Levels of Use* (LoU) identify "what a teacher is doing or not doing in relation to the innovation" (Hall & Hord, 1987, p. 13). It is the sequence (perhaps invariant) that users pass through as they gain in confidence and skill in using an innovation resulting in higher levels of use from non-use to institutionalisation. The sequence of levels with descriptions are provided in Appendix A. The LoU uses a structured interview and observations to obtain the data needed to place participants at one of these levels.

The *Innovation Configuration* (IC) "focuses on describing the operational forms an innovation can take" (Hall & Hord, 1987, p. 14). While the SoC and LoU deal generically with the change process from the social-psychological perspective of those users undergoing the change process itself in the context of the innovation, the IC circumscribes the innovation. The IC uses existing documentation about the innovation and interviews with participants, including facilitators, to prepare a two dimensional chart of the innovation. A series of statements, known as components, are constructed to define the intended outcomes of the innovation. These components are usually listed vertically, must be able to be observed, and represent the innovation implemented fully and successfully. For each component a range of variations representing less than satisfactory implementation are described.

Variations are listed horizontally, thus forming the two-dimensional chart. An example is given in Appendix A.

Computers in Classrooms: the Adoption of an Innovation

The research in educational computing which has applied CBAM typically has done so to focus on the growing interest in issues concerning the implementation of computers into classrooms. It has become increasingly clear that to address issues such as the effectiveness of using computers to support learning and why computers have had such little impact on schooling, research is needed on how computer support is implemented and, particularly, on the role of the teacher. The concerns-based models are designed to support research into the implementation of an educational innovation and particularly focus on teachers. Marcinkiewicz (1994) argues for the use of concerns-based models in educational computing research because to “understand how to achieve integration, we need to study teachers and what makes them use computers, and we need to study computers and what makes teachers want to- or need to- use them” (p. 234).

In the same way that CBAM is one of a number of models developed from Fuller's work, there are many models currently being developed for use in research with computers in classrooms that have their roots in the CBAM Project.

The application of CBAM, or models based upon CBAM, to research concerned with the use of computers in classrooms is gaining interest throughout the world. Most interest appears to be with the *Levels of Use* and *Stages of Concern* dimensions (i.e. user focus) (Marsh, 1988), more recently there is more interest in including an *Innovation Configuration* (i.e. innovation focus). This is really the basis of many of the frameworks being developed at the moment. Two of the few to applied all three dimensions to a study were Carbines (1986) and Hope (1995), who both considered the use of computers in primary school classes. A few smaller studies have also been reported (Cicchelli, 1984; Overbaugh & Reed, 1995) while a number of researchers in Europe (e.g. Vernooy-Gerritsen, 1994) and USA (e.g. Marcinkiewicz & Welliver, 1993) are working at modifying the SoC and LoU to describe the use of computers in classrooms by teachers. Some (e.g. Moersch, 1995) are attempting to construct instruments to measure the LoU of a teacher or class.

Typically the models and instruments have developed around large projects to place computers in schools. A number of models are in their early stages of development but appear to have difficulty in containing the breadth of innovation involved in bringing computers into the classroom. In many cases these models have substantially modified the original dimensions and instruments, which is not condoned by the originators of the CBAM model. Hall and Hord (1987) explain that such modification would require further validation in line with the original development and could not rely on the validation of the original CBAM instruments.

Hope (1995) conducted a study using all three dimensions and instruments of CBAM to investigate the impact of microcomputer technology on classroom teachers at an elementary school in Florida, USA. He was a participant investigator (Principal of the school) and considered the concerns of 18 teachers in using computers, factors that promoted the use of the computers, barriers which impeded teacher acceptance and use of computers, level of use of computers, and teacher-related outcomes attributable to the technology. He found that teachers initially had concerns at the first three stages of concern (0- Awareness, 1-Informational and 2-Personal), but towards the end a few had more concerns at Stage 3, Management. Consistent with other studies, he found that the main factors teachers reported which promoted their use of computers in administrative tasks were: access to computers, colleague assistance, time to practise, ease of use of computers, encouraging school environment, and training to use computers. Barriers he found were: lack of training, limited access to hardware, lack of interest by teachers, fear of failure, lack of knowledge about integrating computers into the curriculum, too many other things to do, and fear of the computers. Hope also believed that significant hurdles to successful implementation were contributed by delayed delivery of computers, staff turnover, and logistical decisions such as whether to mandate computer use. Overall most teachers reported positive outcomes of the innovation for them personally, such as increased self-esteem despite the barriers.

In terms of LoU, Hope reported that at the beginning of his study all teachers were NonUsers at Levels I (Orientation) or II (Preparation). After three months of exposure to computers in their classrooms, only 19% were NonUsers with 37% being at Level III (Mechanical) and 44% at Level IVA (Routine). Four months later he reported that while 19% were still NonUsers, 50% were now Routine users with one teacher at Level IVB (Refinement). This represented successful implementation of the innovation. However, the innovation was very limited in scope, as indicated by the *Innovation Configuration* which defined a small number of very specific outcomes for the innovation. Carbines (1986) also applied all

three CBAM dimensions in an Australian study investigating the relationship between the degree of implementation of computers in primary schools for learning and selected characteristics of schools. He found that higher levels of use and lower concerns about coping were evident where the Principal was task-oriented rather than staff-welfare-oriented, where there was less participation of teachers in planning the implementation, where the Principal provided more resource support, and where emphasis was placed on needs assessment, feedback and goals.

Instructional Transformation model

Reiber and Welliver (1989) and later Marcinkiewicz (1994) developed the Instructional Transformation model, which has been used by a number of researchers (e.g. Knee, 1996), to help schools design their restructuring plans using technology. Their model developed from a study of adoption behaviour drawing on the CBAM model and the work of Rogers (1983). They saw much value to educators in the model, particularly in “recommending staff development, remediation, or differential staffing” (Marcinkiewicz & Welliver, 1993, p. 5). The Instructional Transformation Model proposes a hierarchy for the successful application of technology to education using a LoU type of approach (Figure 6). This hierarchy involves the following five steps (a) familiarization, (b) utilization, (c) integration, (d) reorientation, and (e) evolution (Rieber & Welliver, 1989, p. 21) which gives a six level model with the inclusion of the *Non Use* level prior to the first step. The model is shown as a diagram using stairs to represent the different levels in the hierarchy.

These stages suggest that the educator must go through a period of familiarisation (Entry) representing baseline exposure to technology, utilisation (Adoption) occurring when teachers try the technology, integration (Adaption) beginning the appropriate use of ICT, reorientation (Appropriation) where ICT becomes a part of the learning context and evolution or revolution (Invention) where there is a change in methods and media to facilitate learning.

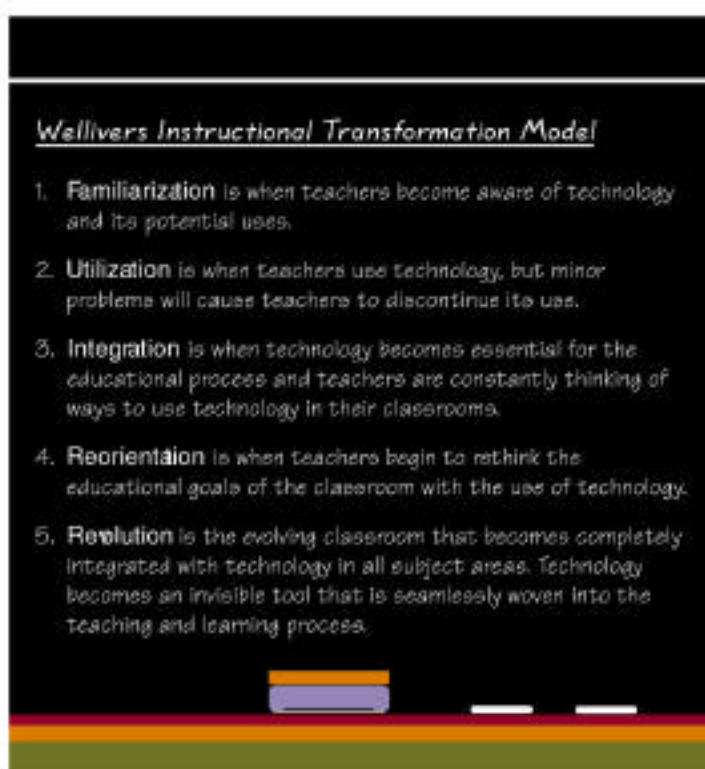


Figure 6 Instructional Transformation Model (Only five levels are given here, there is a Non-Use level prior to Familiarisation.)

Rieber and Welliver (Rieber & Welliver, 1989) define *Familiarization* as “the process of becoming acquainted with the notion of a computer”, and *Utilization* as “teachers make use of the computers for many educational activities but are not committed” (p. 28). They note that, most educational media have attained only the *Utilization* level which is also true of the current uses of the computer in education. They described *Integration* as involving the “crucial turning point of fully implementing the computer in education” since at this stage “teachers assign a purposeful role to the computer” and demonstrate a “commitment to using the computer for appropriate activities and processes is involved

in this step" (p. 28). The key criterion is that at this level "the computer technology cannot be taken away without disrupting the educational process" (p. 28).

They explain that further levels will be demonstrated "once it is realized that a medium, such as the computer, can be trusted with certain educational responsibilities" (p. 28) which involves the teacher reflecting on the educational process. Marcinkiewicz and Welliver (1993) applied the Instructional Transformation model by developing the Level of Computer Use (LCU) questionnaire to measure the level of use of computers in classrooms by teachers. They were motivated by the perceived "discrepancy between advocacy for the use of computers in education and their actual use by teachers" (p. 1). Originally they considered the full six level model (refer to Figure 6) and items were written for all five stages (i.e. movement between the six levels) of the model and followed the progressive nature of the model. However, when this was tested they found it was difficult to classify teachers' responses. In fact it appeared that several dimensions overlapped and therefore they finally specifically focused only on whether the use of the computer is integral and necessary to the intentions of the teacher. Therefore the final LCU considered only "the expendability of computers", that is, the boundary between the levels, *Utilization* and *Integration*, and classified teachers into two levels of computer use.

According to the Instructional Transformation model "the Integration stage is further characterized by the dimension of a teacher's emergent self-awareness of a role change in teaching from teacher-centred to learner-centred" (Marcinkiewicz & Welliver, 1993, p. 4). Marcinkiewicz and Welliver (1993) explained that, "in a departure from the model, the assessment [LCU] does not encompass the dimension of awareness of role change" (p. 4). It would be difficult to collect these data using a questionnaire, and it should also be noted that the authors of the CBAM adoption model specifically claim that their LoU dimension, which is a similar construct to the Instructional Transformation model, can not be measured by a questionnaire but rather requires observation and interview (Hall & Hord, 1987). Marcinkiewicz and Welliver (1993) considered that it was "not practical or perhaps possible to capture all the dimensions [of the model] simultaneously" (p. 6). In fact, Marcinkiewicz (1994) said that *Evolution* was more of a suggestion than a level.

The LCU was field tested with 23 elementary school teachers and resulted in only 2 inconsistent responses (these indicate the degree of unreliability). It was then administered to 170 elementary teachers (to avoid computing specialist subject area) with the results being shown to be statistically highly reliable which was claimed demonstrated that the model identified "at least two progressive levels" (Marcinkiewicz & Welliver, 1993, p. 5). The study ensured that teachers were confronted with computers in their classrooms, over a period of time, to provide for "cognitive dissonance" which meant that "exposure to the computers is inevitable and occurs regardless of a teacher's intentions" (Marcinkiewicz, 1994, p. 225). That is, to overcome the typical situation where teachers ignore computers they were forced to a decision point of either seeking information or deliberately avoiding the computers. The study found that only 8% of the 149 eligible teachers were at the *Integration* level, 47% were at the *Utilization*, and 45% at the *Nonuse* level. Therefore about half of the teachers reported not using computers for teaching. The study concluded that the results suggested that, "the adoption of computer use may occur incrementally or hierarchically as described by instructional transformation" (p. 232). That is, it supported the concept of a sequential and hierarchical model to describe the adoption of computer use in the classroom by teachers.

The Stages of Concern with Information Technology Model

The Netherlands has long been considered to be a home of innovation in education, particularly with regard to using technology in teaching and learning. For more than a decade, educational researchers, policy makers, administrators and teachers in The Netherlands have been working together to improve their education system which they perceive should include a significant role for computer technology. The focus has been to "reform school curriculum, integrate information technology into the new curriculum, and implement new approaches to teacher support and in-service, all at the same time" (Collis, 1994, p. 12). To this end they standardised the first two years of secondary education to a 15 subjects common curriculum, which included 20 hours of introduction to information technology. They established a core set of objectives for students with regard to information technology which were integrated into eight of the new subjects.

Much of this reform has been embodied in two related projects, PRINT (PProject on the Implementation of New Technologies), and PIT (Project Information Technology). These projects had a significant evaluative component which was based on using a modified CBAM model to evaluate teachers (Collis, 1994). The PRINT project proposed a seven-phase stages of concern model (refer to Table 4) which represents the obstacles teachers must overcome to make use of computers in their

classrooms (Vernooy-Gerritsen, 1994). The project led to the PIT project, which refined these stages to a CBAM based model (refer to Table 5), referred to as *Levels of Involvement with IT as an Innovation in School Practice* (Collis, 1994). Collis (1994) was involved in using CBAM to evaluate teachers in the PIT project.

The aim of PIT was to support teachers in moving to Levels 5, 6, and 7 (see Table 4), that is, at least an *Extended Impact* level of involvement. She also felt that as a result of PIT, even non-PIT teachers should move to at least Level 4, that is a *Routine Use* level of involvement. The project also considered interrelationships between variables and level of involvement. The evaluation used questionnaires with 725 teachers, which asked for their perception of their current level of involvement and the level they expected to reach by the end of PIT. PIT teachers were also asked to assess the level of involvement of non-PIT teachers in their subject area at their school. PIT teachers perceived the benefits of the project as better remedial support, better stimulation of students' meta-cognitive skills, and more differentiated variety of learning activities (Collis, 1994). However, they did not see benefits in presentation and demonstration in lessons, group and project work, helping students produce reports and graphics, access to new sources of information, support for the implementation of the new curriculum, and helping to explain concepts and ideas to students (Collis, 1994).

Table 4

Stages of Concern with Information Technology Model from the PRINT Project

Phase	Concern	Teacher	Description of Development
0	Awareness		hardly any interest in information technology
1	Informational/ personal	little knowledge	asking information, interest in the role of the teacher
2	Consequence	any knowledge of possibilities	testing courseware, what is its importance to pupils
3	Management	incidental use of courseware	teaching processes, using software in the classroom
4	Collaboration	structural use of courseware	integration in curriculum, collaboration with others
5	Refocusing 1	pioneer	adaptation of courseware after use
6	Refocusing 2		possibility of new alternatives, forerunner

Note. Table taken from van Pelt and Vernooy-Gerritsen (1994, p. 8).

Table 5

Stages of Concern from the PIT Project, Levels of Involvement with IT as an Innovation in School Practice

Stage	Type of Concern	Action Toward Innovation
1 Unawareness	None	Total inaction
2 Information Level	"Should I know something about this?"	Casual interest in obtaining some information.
3 Initial Personal Skills Level	"How does this work? Will I be able to figure it out and handle it?"	Wants to have the chance to try it out and to have enough skills to do so.
4 Level of Routine Use of Some Aspect of the Innovation	"Is there a manageable way that I can come to regularly use this innovation so that some need of mine is met?"	Has found a use for the innovation and a handy way to execute that use, so that it becomes routine.
5 Extended Impact Level	"Are there other aspects of my educational practice that could benefit from a broader use of this innovation?"	Begins to change aspects of professional routine to incorporate more of the innovation's potential.
6 Contributor's Level	"How can I work together with others to exploit the value of this innovation?"	Becomes involved in collaborative activities associated with the innovation.
7 Leadership Level	"How might educational practice be changed through exploiting this innovation? How should the innovation itself be altered?"	Develops a leadership role, after reflection, contributes to the evolution of the innovation itself.

Note. Table taken from Collis (1993, p. 14).

Levels of Technology Implementation Framework

Moersch (1997) has reported his development of a *Levels of Technology Implementation* (LoTi) framework which defines seven levels of the implementation of computers in a school. The levels are based on the original CBAM levels and are called: *Non-use, Awareness, Exploration, Infusion, Integration (mechanical), Integration (routine), Expansion, and Refinement*. From this framework he has developed an instrument to calculate what he refers to as the computer efficiency at a school site. Computer efficiency is defined as the "degree to which computers are being used to support concept-based or process-based instruction, consequential learning, and higher order thinking skills" (p. 52). The instrument accumulates the products of the LoTi level, proportion of computer use, proportion of student use and number of computers to produce an index for comparison between schools. Clearly the originators of the CBAM model would not approve of such an instrument since it uses a questionnaire rather than observation and interview and uses numerical calculations to arrive at levels (Hall & Hord, 1987).

ACOT Model for Teacher Proficiency in Technology-Based Classrooms

The *Apple Classrooms of Tomorrow* (ACOT) projects have been conducted for more than ten years in the USA and are well reported (e.g. Dwyer et al., 1991; Sandholtz et al., 1992). There were five projects (different sites) with varying parameters but all involving classroom learning environments referred to as "high-access-to-technology environments" (Sandholtz et al., 1992, p. 479). A developmental model for categorising the progression of teachers towards expertise in technology-based classroom management was developed from these projects (Marcinkiewicz & Welliver, 1993; Sandholtz et al., 1992). The model defined three stages of teacher proficiency with technology: *Survival, Mastery and Impact* which are described in Table 6. It should be noted that the ACOT research team also developed a model to describe instructional change incorporating five stages: entry, adoption, adaptation, appropriation, and invention (Dwyer et al., 1991). They distinguished this model from the former, which they claimed dealt primarily with the concerns of teachers for classroom management associated with having computers in their classrooms (Sandholtz et al., 1992). Findings from ACOT projects relevant to the present study are discussed later in this chapter.

Table 6

Apple Classrooms of Tomorrow (ACOT) Three Stage Development Model for Teacher Proficiency in Technology-Based Classrooms

Stage	Defining features
Survival	<ul style="list-style-type: none"> • preoccupation with own adequacy • concern about ability to maintain control over the classroom and students • react to problems rather than anticipate them
Mastery	<ul style="list-style-type: none"> • anticipate problems and develop solutions to them • increased technical competence and experience and confidence
Impact	<ul style="list-style-type: none"> • focus on effects of teaching on students • use technology to assist in managing the classroom

Note. Table based on Sandholtz et al (1992).

In discussing the ACOT projects, Mandinach and Cline (1994) added an *Innovation* stage to the ACOT model for their Systems Thinking and Curriculum Innovation (STACI) project. They described this stage in terms of the teacher being involved in restructuring the curriculum and learning activities. However, they did not assume that all teachers went through these stages systematically, for they recognised that some teachers would move between stages both in a progressive and regressive sense depending on a variety of factors and pressures. Sandholtz et al. (1992) concluded from the ACOT projects that teachers only changed slowly, often regressed temporarily, and that "teachers progress through stages of concern in an idiosyncratic manner" (p. 479). However, Mandinach and Cline (1994) proposed a manner in which teachers moved between the STACI model's four stages and developed three systems models using system thinking concepts and system diagrams produced with the STELLA® software package to explain this. These models were used to discuss computer-based curriculum innovations at three levels: *Student Learning Level, Classroom Processes Level, and Organizational Change Level*.

The model developed for the second of these levels, the *Classroom Processes Level* model, is particularly relevant. It involves five domains: instruction, curriculum, resources, support, and

accountability. Each of these domains has variables which are either stocks (accumulators) or flows (add to or delete from stocks). For example, the instruction domain has four variables: two stocks, interactive learning and learner-directed learning; and two flows, technology, and student and teacher role change (refer to Figure 7). Technology feeds into interactive learning which in turn feeds into learner-directed learning which is also affected by the change in roles of students and teachers. That is, this model assumes that using technology will support a move to interactive and learner-directed learning, which Mandinach and Cline (1994, p. 180) claim are “the two hallmarks of computer-based curriculum innovations” (p.181). This supported the finding of Dwyer et al. (1991) that ACOT teachers changed their pedagogy to be more child-centred, with collaborative environments which had a more active orientation.

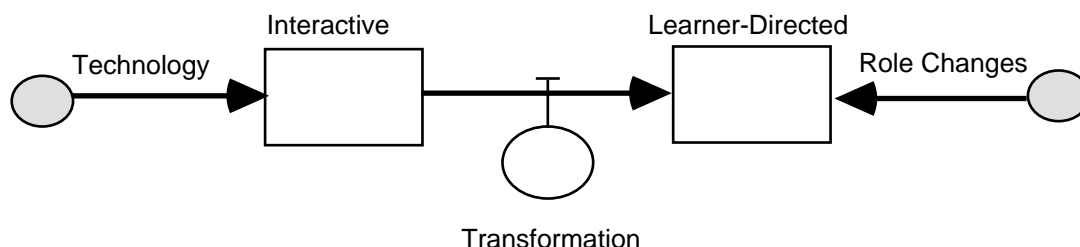


Figure 7 The instruction domain of the classroom processes level model from the STACI project (adapted from Mandinach & Cline, 1994, p. 180).

The Journey an Educator Must Travel to Encourage Change

As long-term projects like the Apple Classrooms of Tomorrow (ACOT, 1995) studies show, teachers must travel through a number of stages to integrate ICT fully into their classrooms and their teaching programs (see Table 7).

Table 7

Apple Classrooms of Tomorrow (ACOT) Stages of Development

Stage	Examples of what teachers do
Entry	Learn the basics of using the new technology.
Adoption	Use new technology to support traditional instruction.
Adaptation	Integrate new technology into traditional classroom practice. Here, they often focus on increased student productivity and engagement by using word processors, spreadsheets, and graphics tools.
Appropriation	Focus on cooperative, project-based, and interdisciplinary work—incorporating the technology as needed and as one of many tools.
Invention	Discover new uses for technology tools, for example, developing spreadsheet macros for teaching algebra or designing projects that combine multiple technologies.

Source: A Report on 10 Years of ACOT Research (1995, p16)

Christine Harrison (2000), a Western Australian primary school teacher has travelled such a journey over the last decade, describing the process as “you begin at the *entry stage* where you do not use technology in your classroom for yourself, but rely on a specialist/support teacher to do it for you”. Many educational institutions and educators stay at this level as one person becomes the expert or ‘early adopter’ supporting the technology program while the others remain teaching as they always have.

During the second stage, *adoption*, Harrison (2000) states “you use one or two software applications that you find useful for yourself, but you do not use the software as part of the lesson for your students”. For example, the use of the Internet by the teacher to prepare lessons but not applied to classroom lessons such as Webquests where students are actively involved in finding their own information.

The *adaptation* stage is “where you begin to assign simple activities for students such as typing work and peer editing”. Here direct instruction is usually the primary mode.

The next stage, *appropriation*, occurs when teachers use technology for the things that make it unique. This is the stage where higher order thinking, collaborative learning and learner centred learning activities are used. Management structures are beginning to loosen up and student tasks are more open-ended and multi-disciplinary.

The ultimate stage is *invention* that shows innovation. At this stage students are engaged in leaning activities that may or may not resemble traditional practices. Students have many options when approaching a new learning unit and can extend beyond the traditional boundaries placed by teacher knowledge, truly constructing their own knowledge. At this stage Harrison (2000) describes the use of portfolio assessment used by her to show how her students are achieving outcomes. Such records are burnt on CD-ROM to show parents. This is an example of a teacher using the technology innovatively to achieve learning outcomes.

The ACOT project shows that this journey is enhanced when teachers and students have had unlimited access to technology in the classroom and are able to look at different approaches to teaching and learning. In fact teachers who have had regular access to technologies in their classrooms over several years, experience significant changes in their instruction, but not until they have confronted deeply held beliefs about schooling.

Technology in American Schools: Seven Dimensions for Gauging Progress

The Milken Family Foundation is a private non-profit organization whose mission is to discover and advance inventive and effective ways of helping people help themselves and those around them lead productive and satisfying lives. It was founded by the Milken brothers and focuses mainly on areas of education, medical research and Jewish culture. One of its initiatives is the Milken Exchange on Educational Technology (<http://www.milkenexchange.org>) that conducts research, presents news and reports on the use of ICT to support learning in schools.

In 1998 the Milken Exchange on Educational Technology published a report titled, *Technology in American Schools: Seven Dimensions for Gauging Progress* (Lemke & Coughlin, 1998). Then in 1999 a companion publication was released titled: *Professional competency continuum: professional skills for the digital age classroom* (Coughlin & Lemke, 1999). This included discrepancy analysis tools (questionnaires) for use by policymakers and school planners. Since then further publications have been released leading from these, including: *Transforming learning through technology*.

Their intention was to create a framework to support educators in “charting their course toward the effective use of technology in learning and show evidence of progress along that path” (p. 3). The framework is intended to provide indicators for policymakers to assess the status of schools in terms of their use of ICT to support learning. The focus is very much on public return on investment in ICT in education. However, they also consider that it will focus vision, provide a research agenda and be a planning tool. The framework is presented as a set of seven interdependent dimensions: Learners, Learning Environments, Professional Competency, System Capacity, Community Connections, Technology Capacity, and Accountability.

They claim that changes in society today (global economy, knowledge workers, new family structures, changing demographics, and crime rate/violence) along with pressures on schools to change today (industrial model, inequities, new brain research, learning theory, and new workforce skills) will require educational technology to be used to transform schools to prepare students to “live, learn and work successfully in a digital communication age”. They believe that this requires: high academic standards, technological fluency, communication skills, interpersonal skills, information literacy, independence in learning, critical thinking abilities, and economic viability all within the “context of a digital communication age”.

They provide a continuum of progress for each dimension, based on the “stages of instructional evolution” from the ACOT program, using three levels: Entry, Adaptation, and Transformation. For each dimension a number of key areas are identified and also described in terms of the three levels (refer to Appendix B for a paraphrased version). For example, for the first dimension, Learners, the key areas are: Fluency (proficient in the use of ICT), Strengthening the basics (learning the “basics with more depth and understanding”), developing higher level skills (“thinking, understanding, constructing knowledge and communicating”), increasing relevancy (“real-life applications” and emulating the workforce), motivation to learn (intrinsic), recognition of tradeoffs (making choices about using technology in society).

One of the seven interdependent dimensions is *Professional Competency*. They have developed a Professional Competency Continuum comprising five key areas mapped over the three levels (refer to Appendix B).

There appears to be an assumption that using ICT to support learning requires change for all teachers whereas clearly some teachers (the authors included) have been creating appropriate learning environments for years without using ICT. However, these teachers tend to use ICT because they readily perceive that in doing so they will provide even better environments (Becker et al., 1999).

This seven dimensions framework also appears to confuse system, school and classroom teacher variables. It would be much more useful to separate them. For example, this would allow for the identification of the current practices of a classroom teacher and then consider the reasons for those practices and what is required to progress. This may then require an analysis using a school or system framework because there may be obstacles to progress for the teacher that are results of school or system variables.

There also appears to be confusion over the purposes of using ICT to support learning – computer literacy (curriculum content) and/or computer supported learning environments (curriculum medium). That is, some teachers (more than others) need to use ICT to connect with workplace and society conditions (e.g. Business Education teacher using MYOB). For a Physical Education teacher this may not be a reason for using ICT. However, all teachers may use ICT to support learning environments (the processes of learning) to improve them in many ways (learner-centred, knowledge-centred etc.).

National Educational Technology Standards for Teachers (NETS)

The **International Society for Technology in Education (ISTE) NETS for Teachers** Project, was developed with a grant from the US Department of Education, as part of its Preparing Tomorrow's Teachers to Use Technology initiative. ISTE facilitated a series of activities and events resulting in a national consensus on what teachers should know about and be able to do with ICT. At the same time they worked on a NETS for Students Project. It should be noted that Intel, Apple Computers and the Milken Exchange on Educational Technology all provided substantial contributions to the projects.

The project aimed to provide models for teacher preparation programs to use in incorporating ICT in the teacher preparation process and disseminate these promising practices for preparing tomorrow's teachers to use ICT effectively for improving learning. Major functions of the project were to (International Society for Technology in Education, 2000):

1. develop a comprehensive set of performance-based technology foundation standards for all teachers reflecting fundamental concepts and skills for using technology to support teaching and learning;
2. define essential conditions for teacher preparation and school learning environments necessary for effective use of technology to support teaching, learning, and instructional management;
3. develop standards-based performance assessment tools for measuring the achievement of the technology foundation standards and as a basis for certification, licensing, and accreditation; and
4. identify and disseminate models of teacher preparation where candidates receive experiences preparing them to effectively apply technology to support student learning; and
5. establish a **National Center for Preparing Tomorrow's Teachers to Use Technology (NCPT3)** which will provide coordination, leadership, and support for the PT3 initiative and dissemination of program results.

The project describes standards, assessments, and conditions that facilitate the use of technology to support student learning. Assessment systems are designed to assist teacher preparation programs in evaluating the success of their programs in preparing their candidates and graduates in use of technology to support student learning. The project explains the rationale for using ICT as “Our Educational System Must Produce Technology Capable Kids” (International Society for Technology in Education, 2000, p. 1). This is expanded by suggesting that ICT can enable students to become:

- Capable information technology users
- Information seekers, analyzers, and evaluators
- Problem solvers and decision makers
- Creative and effective users of productivity tools
- Communicators, collaborators, publishers, and producers
- Informed, responsible, and contributing citizens

As with the Milken Technology Exchange's model from the outset this project has not taken account of the two general rationales for the use of ICT and has subsumed ICT support for processes of learning

and teaching within the technological literacy rationale. They describe the provision of learning environments that,

... provide rich opportunities for students to find and utilize current information and resources, and apply academic skills for solving real-world problems. These environments engage students in activities that have educational technology skills and relevant curricular content interwoven.

Teachers must be prepared to empower students with the advantages technology can bring. Schools and classrooms, both real and virtual, must have teachers who are equipped with technology resources and skills and who can effectively teach the necessary subject matter content while incorporating technology concepts and skills. Real-world connections, primary source material, and sophisticated data-gathering and analysis tools are only a few of the resources that enable teachers to provide heretofore unimaginable opportunities for conceptual understanding.

Standards and Performance Indicators for Teachers

NETS for Teachers provides a set of standards and performance indicators that “all classroom teachers should be prepared to meet” (International Society for Technology in Education, 2000, p. 9) and that can be accessed from their website (<http://www.iste.org/>). These are grouped under six general classifications:

- I. Technology operations and concepts
- II. Planning and designing learning environments and experiences
- III. Teaching, learning, and the curriculum
- IV. Assessment and evaluation
- V. Productivity and professional practice
- VI. Social, ethical, legal and human issues

Then **Performance Profiles** are given for pre-service, beginning and completion of first-year of teaching. For example, upon completion of first-year of teaching there are 21 performance targets that are connected with the six areas of standards. An example of a performance target is, “assess the availability of technology resources at the school site, plan activities that integrate available resources, and develop a method for obtaining the additional necessary software and hardware to support the specific learning needs of students in the classroom. (I, II, IV)” (International Society for Technology in Education, 2000, p. 24). The roman numerals in the brackets refer to the classifications of standards to which the target relates.

Purpose of the Standards

It appears that the standards and performance profiles are more focused at teacher training, district and school planning than supporting individual teachers. However, they may still be of some use in guiding a teacher. There is a recognition that for ICT to be used effectively requires more than just the technology and competent teachers. The report outlines essential conditions to create learning environments with ICT support.

- Vision with support and proactive leadership from the education system
- Educators skilled in the use of technology for learning
- Content standards and curriculum resources
- Student-centred approaches to learning
- Assessment of the effectiveness of technology for learning
- Access to contemporary technologies, software, and telecommunications networks
- Technical assistance for maintaining and using technology resources
- Community partners who provide expertise, support, and real-life interactions
- Ongoing financial support for sustained technology use
- Policies and standards supporting new learning environments

Clearly the focus is on providing constructivist learning environments supported by ICT which are referred to as “new learning environments”. They state that,

Traditional educational practices no longer provide students with all the necessary skills for economic survival in today's workplace. Students today must apply strategies for solving problems using appropriate tools for learning, collaborating, and communicating.

Once again there appears to be a denial of the existence of good educational practices prior to the advent of ICT.

Performance assessment standards for courses

Most recently ISTE has developed performance assessment standards for initial and advanced educational computing and technology programs (International Society for Technology in Education, 2001) including:

- (1) the technology facilitation initial endorsement;
- (2) the technology leadership advanced program; and
- (3) the secondary computer science education preparation programs.

Technology Facilitation (TF) -- Initial Endorsement Standards

Technology Facilitation (TF) endorsement programs meeting ISTE standards prepare candidates to serve as building/campus-level technology facilitators. Candidates completing this program will exhibit knowledge, skills, and dispositions equipping them to teach technology applications; demonstrate effective use of technology to support student learning of content; and provide professional development, mentoring, and basic technical assistance for other teachers who require support in their efforts to apply technology to support student learning.

Technology Leadership (TL) -- Advanced Program Standards

Technology Leadership (TL) advanced programs meeting ISTE standards prepare candidates to serve as technology directors, coordinators, or specialists. Special preparation in computing systems, facilities planning and management, instructional program development, staff development, and other advanced applications of technology to support student learning and assessment will prepare candidates to serve in technology-related leadership positions at district, regional, and/or state levels.

Secondary Computer Science Education (CSED) -- Endorsement/Degree Program Standards

Secondary Computer Science Education programs meeting ISTE standards prepare candidates to serve as teachers of computer science in secondary schools. They focus on preparing their students in the more technical aspects of computing such as problem analysis, algorithm selection and evaluation; program design, implementation, specification, and verification; and systems analysis.

A set of PROGRAM RUBRICS have been developed. Aspects of the Technology Facilitation (TF) Program Rubric may be of value in determining what individual teachers should be doing as well as for teacher facilitators and course designers. This would particularly be the case if it were interpreted for teachers and children as students, rather than facilitators and teachers as students.

For each of the six areas of standards and associated performance indicators for teachers the rubric describes three levels of performance: Approaches Standard, Meets Standard, Exceeds Standard. For example, for Standard II (Planning and Designing Learning Environments and Experiences) and the Performance Indicator E (Plan strategies to manage student learning in a technology-enhanced environment) the rubric provides the following:

Approaches Standard	Engage in ongoing planning of lesson sequences that manage student learning in a technology-enhanced environment.
Meets Standard	Provide teachers with a variety of strategies to use to manage student learning in a technology-enhanced environment and support them as they implement the strategies.
Exceeds Standard	Model a variety of strategies to manage student learning in a technology-enhanced environment and support the teachers as they implement the strategies.

Technology Maturity Model

This model (abbreviated as the TMM) addresses what the authors (Sibley & Kimball, 1998) call the challenges of 'the use of technology' (referring to ICT in schools). The challenges include the need to approach ICT implementation in a cyclic manner, over an extended time frame, since single attempts and first efforts are often aimed well enough, but rarely persist long enough (McLaughlin, 1990; Tester, 1991). Two key components of this model are its ability to address both processes and products and encourage best practice approaches to both. These two facets are addressed in the model's Benchmarks section. For example each of their benchmarks has Behavioural and Resource Infrastructure criteria.

The model has significant complexity and breadth of scope, in that it is intended to help monitor the ICT development of a school or school district over a substantial period, and provide direction for their planning and implementation with ICT.

There are three basic characteristics that underpin the TMM. These are the Improvement Cycle, the Maturity Indicators and the TMM tools (many of which are now available online).

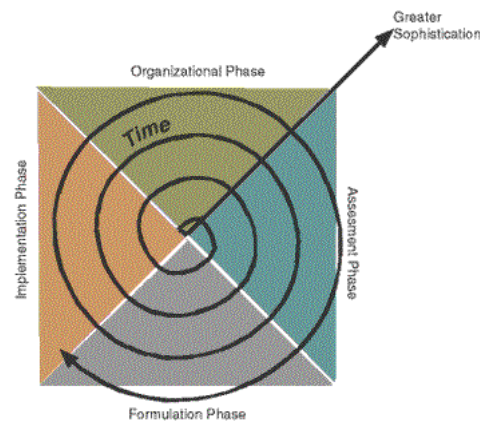


Figure 8 Technology Maturity model spiral.

The Improvement Cycle of spiral development covers four phases, namely Organizational, Assessment, Formulation and Implementation Phases. The diagram suggests how a school or district might develop over time using this approach.

The complete model is composed of nine steps and processes which are intended to help translate plans into action. These are 1: an Improvement Cycle, 2: Planning Phases, 3: Spiral Refinement, 4: Concurrent planning and Improvement, 5: Comprehensive Planning, 6: Maturity Indicators, 7: Assessment Instruments, 8: Benchmarks and 9: a Plan Analysis rubric to allow districts to compare themselves.

The Maturity Indicators are of particular interest .

The Indicators of a school or a teacher's progress are gauged by what are called benchmark stages. There are four stages:

- 1) The Emergent Stage
- 2) The Islands Stage
- 3) The Integrated Stage
- 4) The Exemplary Stage

These stages are measured in multiple areas, using different indicators tailored to each area. As examples, consider the Emergent and Islands Stages.

The Emergent Systems Stage is characterized by:

- Lack of formal support when using computing technology for instruction
- No formal plans, policies or procedures exist to ensure the efficient and appropriate acquisition or use of technology throughout the Institution
- Computers are used sporadically throughout the Institution
- Institution wide coordination to ensure grade level and program level access is absent
- Formal support for teacher training is minimal

The Islands of Technology Stage is characterized by:

- Regular use of computers at one or more grade levels and program levels at each school within the Institution on a regularly scheduled basis
- Formal plans, policies and procedures exist to facilitate the optimal use of technology in both instructional and administrative areas throughout the Institution
- Institution sponsored and school sponsored training is available
- Technology has budgetary visibility at the Institutional level and school/program level
- The instructional delivery system is somewhat dependent on technology

Although it may appear to be rather technologically oriented, it is important to understand that these characteristics are implemented by rating against the benchmarks in each of five sections important for ICT uptake namely Administrative, Curricular, Support, Connectivity and Innovation sections. These areas are described as FILTERS for each category. An example of the benchmarks (which can be implemented by utilising the TMM online tools) for the Administrative and Curricula filters is given in Table 8, taken from their website. Firstly the Administrative filter has Categories called Policy, Learning and Budget. Only Policy and Planning are given here.

The Curricular filter on the other hand has categories of Electronic Information and Assessment. These are listed in Table 9. Note that both filters have the product and process approach implemented as 'Behavioural' and 'Resource Infrastructure' types in every one of these filters.

The stages of the TMM model address from a technological perspective the issues of both teacher uptake as well as school development. Its online version is sponsored used across the US, by Compaq. Although sophisticated and rich as a tool its technological rather than learning focus could be counted against it. But its completeness in approach is in its favour.

Table 8
Administrative filter for Maturity Model benchmarks.

Category	Type	Emergent	Islands	Integrated	Exemplary
Policy	Behavioral	Appropriate technology use is considered, but is informal and inconsistent.	Appropriate technology use is formalized, but is mostly ignored by many in the school.	Appropriate technology use is formalized and embraced in many parts of the school.	Appropriate technology use policy is formalized and fully supported at all levels of the organization.
	Resource Infrastructure	No technology policy exists.	Some policy exists, loosely articulated and mostly informal, with no formal approval.	Formal policy exists, but is not comprehensive in nature, or has not been approved by the governing body.	Comprehensive policy exists and has been approved by the organization's governing body.
Planning	Behavioral	Informal planning process, isolated to projects, and is budget driven.	Formal planning takes place, but is isolated to specific projects with some connection to other planning efforts.	School wide comprehensive planning receives informal review, and is connected to other planning efforts.	School wide comprehensive planning with formal evaluation and connected to other planning within the school and district.
	Resource Infrastructure	Informal plan.	Formal plan with isolated implementation and little or no connection to other planning efforts.	Comprehensive technology plan that receives informal review and some connection to planning efforts.	Comprehensive technology plan with formal evaluation and connection to planning in the school and district.

Table 9

TMM benchmarks in the Curricula filter.

Category	Type	Emergent	Islands	Integrated	Exemplary
Electronic Information	Behavioral	Staff and students rarely depend upon electronic resources and use them sporadically.	Students and staff are somewhat dependent upon information resources and utilize them often.	Students and staff are very dependent upon information resources, and utilize them regularly.	Students and staff are heavily dependent upon information resources and use them daily.
	Resource Infrastructure	Resources are scarce, limited to materials like electronic encyclopedias. Few students have access.	Resources are beyond basic, but lack depth and are not available to all areas of the school.	Resources are fairly comprehensive providing depth or diversity, but not both. Access is available to most.	Resources are comprehensive providing depth and diversity. All students have regular access.
Assessment	Behavioral	Few staff and no students use technology for assessment of student work.	Used by many of the staff and some of the students for the assessment of work and self assessment.	Used by most of the staff and many students for the assessment of work and self assessment.	Technology is an essential part of the assessment process for students, teachers, and parents.
	Resource Infrastructure	Electronic tools are rarely used for assessment and are not readily available.	Some assessment and reporting tools are available, with a focus on traditional assessment measures.	Many assessment and reporting tools are available, with tools limited in scope and availability.	Fully integrated assessment and reporting tools are available for student and staff use.

Typology of ICT Uptake

The principal aim of the research giving rise to the Typology of ICT Uptake model was to develop a framework by which teachers’ pedagogies and capabilities with ICT could be mapped onto some multi-stepped scale as part of assessing their ICT uptake. A four-stage typology of ICT uptake was developed.

Stages (Dependent, Counter-dependent, Independent, Interdependent)

The typology was derived from a series of models of learning described by Brundage & McKerracher (1980) and Boud (1988) and with considerable input from studies of teachers and their teaching practices with ICT. In this sense it was grounded in the teachers’ data as well as reliant on previous research. The model describes four stages: Dependence, Counter-Dependence, Independence and Interdependence (shown in Figure 9). These stages reflect typical phases through which all learners pass they achieve mastery on any new topic they are learning. ICT is simply another topic for learners to master, in this less techno-centric conception of ICT uptake as a learning issue.

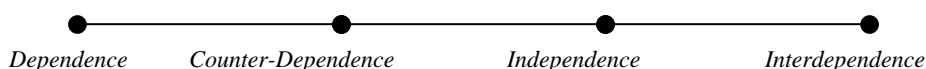


Figure 9: The four stages for learning new material (from Boud, 1988) and adapted to this model of ICT uptake

Within each stage of the model, the relevant literature provides descriptions that can help to identify how teachers feel and react. Through these descriptions it would seem possible to allocate any teacher to a location on the scale.

Factors (Bloom’s head, heart and hand dimensions)

To improve triangulation and to ensure consistency of reaction from teachers, descriptions for the typology were further developed to provide a more sensitive means to identify teachers’ positions. Three domains were developed for each of the stages to enable different aspects of teachers’ experiences and predispositions to inform their placement. These three domains are described as: feelings, understandings and behaviours. The domains were chosen to match the domains of human activity proposed by Bloom in the 1950s and remain a useful distinction (Krathwohl, Anderson, & Bloom, 2001). The stages describe teachers’ affective states, their cognitive states and the ways these are manifest in their actual teaching. If these stages were truly distinct and credible, then it was expected in developing the typology that teachers would be located at one stage, with their ratings for feelings, understandings and behaviours falling roughly into the same stage.

Following this line of reasoning, the typology seemed to promise a means by which, in theory, ICT uptake could be measured by progress along the four stages and within the three domains simultaneously. The typology was presented as a 4x3 matrix (Figure 10) with cells defining the basic layout. It was named the ADL uptake model in an attempt to capture the role of Autonomy, Dependence and Learning in the ICT uptake process.

Stage \ Domain	Dependence	Counter-Dependence	Independence	Interdependence
Feelings				
Understandings				
Behaviours				

Figure 10 Four stages of ICT uptake proposed as the ADL model

Sample indicators

To enable the typology to be applied within general settings, distinct and unique descriptions for each of the cells were developed. These descriptions needed to provide ways to describe teachers across the 4 stages within the 3 domains. Figure 11 demonstrates descriptors taken from the *Understandings* row across the 4 stages.

Understandings	Survival issues with ICT dominate; Concerned more with own mastery and learning	Limited/local thinking about ICT; Teaching oriented	Directed, focussed ICT thinking; Teaching and learning oriented	ICT thinking, usage now second nature; Learning oriented, student focussed
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Figure 11 Example of descriptors for the four-stage model, in this case over the domain 'Understandings'

Each cell of the 4x3 table was further elaborated with Pointers that are representative of that stage and domain. For example at *Dependence*, the teachers’ *Understanding* might typically include some but probably not all of these: *Wary of ICT’s flexibility, instability; questions own role; cannot yet comprehend ways to use ICT broadly; believes ICT is an object to be examined, learned, taught about; seeks explicit even unequivocal standards, regards explicit step-by-step guidance as critical; prefers single solutions.*

These Descriptors and Pointers are not indicative of fixed immutable steps that every learner passes through but general and overall predictable patterns to their feelings, thoughts and behaviours, which are representative of each stage. Some will pass through them more quickly than others for example, but the distinctions are, in Brundage & MacKeracher’s terms, “an aid to analysis and ... not meant to reflect universal, absolute differences” (1980, p. 11)

Summary comment

The instrument is designed to help identify teachers’ level of ICT uptake. It was less techno-centric than many previous versions, and was shown to have some utility. Two aspects of describing a teacher’s location were evident. Some fitted easily to the three domains of a category suggesting that they were characterised by that stage and some stability; others tended to straddle two (but rarely more) stages, suggesting that they were in the process of change.

All the possibilities for placement on the scale were expected to describe people with very different needs about ICT and expectations about ICT training. In fact it was evident that these teachers with their diverse views and different ratings on the ICT uptake typology, had quite different support needs

and diverse professional development needs, even though they may have been in the same schools and similar circumstances.

The model was first published in 2002 and therefore has undergone only limited research so far. Nevertheless it appears to provide a reliable and valid way to determine teachers' positions as users of ICT in their teaching and learning. Current evidence suggests that the typology can be used effectively in mainstream settings. If and when this is possible, the typology would appear to provide considerable assistance as a means to helping to ensure that teachers, their support staff and the designers of their professional development programs are targeted in meaningful ways based on their needs and their current capabilities as users of ICT in their teaching.

Diffusion of Innovation model

Nearly 100 years ago the community of American farmers started using a new hybrid strain of corn. The way this technology diffused through the farming community followed a predictable pattern, according to researcher and writer E.M. Rogers (1983). From the explosive uptake of the Walkman to the slow but eventually thorough adoption of the fax machine, Rogers' theory has become known as part of the Diffusion of Innovations – DoI – theory and has been applied widely (eg Geroski, 2000; Holloway, 1996; Lawson & Loudon, 1996; Mahajan & Peterson, 1985). The DoI model argues that there are predictable patterns of communications among community members as a new technological innovation, such as computers in schools, diffuses. The stages that the innovation passes through are, according to this theory:

- knowledge (exposure to its existence, and understanding of its functions);
- persuasion (the forming of a favourable attitude to it);
- decision (commitment to its adoption);
- implementation (putting it to use); and
- confirmation (reinforcement based on positive outcomes from it).

Of course the innovation itself is unchanged, but the community reacts to it in different ways. The early 'knowers', for example, are regarded as having a higher social standing and being better educated. These people are also more aware and likely to use both mass communications channels and also interpersonal ones. Later at the persuasion stage, interpersonal communications channels are regarded in the DoI as more important.

Stages (innovator to laggard)

A well known part of Rogers' work addressed five types of adoptors, namely innovators (described as venturesome); early adopters (respectable); early majority (deliberate); late majority (sceptical); and laggards (traditional). These characteristics can be elaborated upon;

Earlier adopting individuals tend not to be different in age, but to have more years of education, higher social status and upward social mobility, be in larger organisations, have greater empathy, less dogmatism, a greater ability to deal with abstractions, greater rationality, greater intelligence, a greater ability to cope with uncertainty and risk, higher aspirations, more contact with other people, greater exposure to both mass media and interpersonal communications channels and engage in more active information seeking. (Clarke, 1999, p. 1)

Weaknesses of the model as teacher development tool

Although it may be useful to describe a community or a population using these descriptors, it could also be seen as divisive due to its nomenclature. It seems less likely that it will suggest how to help a person looking to make better use of some technological innovation. Further, as a community engages with some innovation, does the model regroup those likely to NEXT take it up as the new innovators, or is there no distinction between the remaining groups? Such weaknesses restrict the DoI approach to a descriptive role, which it does well, but it is less strong in its explanatory power, and less useful still in predicting outcomes, and providing guidance as to how to accelerate the rate of adoption. Its value in an explanatory and descriptive role is illustrated in the discussion on p. 51. Rogers (1999) also argues that this approach may be embedded in the culture in which it was derived (viz. North America in the 1950s and 60s), and hence less relevant, for example, in African or Asian countries, and its utility may diminish as time goes on.

Conclusions From the Models

The models of uptake and ICT adoption described so far could be distinguished on many different scales. It seems useful to classify them based on two characteristics, namely the scope of the target group they address, and the relevance of an individual's learning to the models. On a range from more population or community oriented, down to more individually oriented models, there are approximately four groups, namely the Population Models, System/School Models, ICT Individual Models and Learning Individual Models.

There is no point in choosing or disregarding these models based on such a classification alone, as no model is going to describe perfectly the circumstances that any particular teachers may find themselves in. Recent longitudinal research on literacy learning with children (Rivalland & Loudon, 2002) made two findings of special significance for this review. Firstly literacy development was enhanced when parents, schools and communities worked together, and secondly that no one particular teaching method seemed to work for all children, however children were likely to take up school literacy with greater ease if the transition from pre-school to the early years and to primary school teaching methods was gradual and planned to accommodate the social and developmental needs of the children in each class.

It is not hard to recognize the principle that there are no magic bullets in learning, and so looking for a single solution in this case also may be counterproductive. Nevertheless the classifying of the models above can draw attention to critical facets of the models and will allow more considered selections to be made. An example of a population model is Rogers' DoI approach. A system-based model is the TMM approach, The Instructional Transformation model takes an individualistic approach but places a technological cast upon the task, as the ACOT hierarchy does. The Concerns-Based Adoption Model (CBAM) and even the Typology of ICT Uptake (TIU) model could be described as examples of models focusing largely on the individual rather than any ICT components.

The four categories of models and the actual models which fall into these categories are:

Population models: Diffusion of Innovation model

System models: Milken's 7 dimensions for gauging progress, NETS and the TMM

ICT-oriented micro models: These models are the Instructional Technology model, the ACOT model and the LoT implementation; and

Learning/micro models: CBAM, the TIU and the Stages of concern ICT are the three models that seem, after this review, to have the better orientation towards learning.

Many of the models have a scale of development, and it is these last models whose scales of development are based on some research on learning and therefore have an 'appropriate' orientation.

Aligning with the Australian Context

Currently there are a number of bodies nationally and in each Australian state that are working at policies to guide practice in the use of ICT in schools. In July 2001 at the 12th meeting of the Ministerial Council for Education, Employment, Training and Youth Affairs (MCEETYA), an *Information and Communication Technologies in Schools Taskforce* was established. The terms of reference for that Taskforce are to:

- provide strategic advice to AESOC and MCEETYA on the use of Information and Communication Technologies (ICT) to support teaching and learning
- provide leadership to the Australian education community in the effective use of ICT
- advance the use of ICT that meet the needs of education
- initiate, implement and support national projects related to the use of ICT in education
- provide a forum for Australian education representatives to share information and advance collaborative initiatives in the use of ICT in education. (MCEETYA Information and Communication Technologies in Schools Taskforce., 2002b)

That Taskforce is required to work with the Australian ICT in Education Committee (AICTEC), provide advice to the *education.au limited* Board regarding strategic directions for EdNA Online and associated developments, work collaboratively with the Le@rning Federation - Schools Online Curriculum Content Initiative (SOCCI). The Taskforce will be ongoing, subject to annual review of its Terms of Reference by MCEETYA. An action plan *Learning in an online world: the school education action plan for the information economy* (Department of Education, 2000) was developed by the Education Network Australia (EdNA) Schools Advisory Group and endorsed in 2000 by MCEETYA (MCEETYA Information and Communication Technologies in Schools Taskforce., 2002a, p. 1). The school education vision in that action plan articulated an important shared vision across all Australian States and Territories. Moreover, the action plan identified goals across five interrelated action areas; people, infrastructure, content and services, supporting policies and enabling regulation, and three high priority areas within those five action areas; bandwidth, professional development, and online content. Thus, substantial momentum can be recognised in terms of:

- Development of national collaboration, strategic planning, sharing of information, and projects in the use of ICT in education;
- Continuing recognition of the need for improving infrastructure;
- Continuing recognition of the central importance of professional development of teachers to effectively integrate ICT into schools;
- Emergence of initiatives aimed at taking advantage of the potential of connectivity and students *Learning in an online world*, especially through digital content initiatives,

A number of Department of Education Science and Technology (DEST) funded studies have proposed frameworks for teachers (DEST, 2001, 2002). In the DEST (2001) report "*Making Better Connections*" a framework was used to clarify the goals and purpose of educational technology of a number of programs and initiatives by asking "What educational outcomes do schools and systems hope to achieve by increasing the extent to which ICTs are integrated into classroom practice?" Educators are promoting ICT use in classrooms for several distinct reasons including:

Type A: encouraging the acquisition of ICT skills as an end themselves;

Type B: using ICTs to enhance students' abilities within the existing curriculum;

Type C: introducing ICTs as an integral component of broader curricular reforms that are changing not only how learning occurs but also what is learned;

Type D: introducing ICTs as an integral component of the reforms that alter the organization and structure of schooling itself.

In the DEST (2002) report "*Raising the Standards*" an ICT Competency Framework was proposed, and while these dimensions and stages are not necessarily a linear process of development, a target group is identified for each dimension and stage, assuming that teachers would be continually aspiring to achieve subsequent dimensions/stages in their application of ICT in teaching and learning. The report recommends that standards developed for Australian educators emphasise the specific relevant

dimensions. The mapping of standards developments undertaken for this project revealed numerous examples of non-ICT specific standards, both generic and subject specific and that an ICT competency framework must address all these dimensions of the application of ICT in schools if it is to complement existing generic and subject-specific standards at the same time as doing justice to the transformative potential to reshape these very standards (DEST, 2002).

Table 10

Dimensions of ICT Use, Stages of ICT Development and Target Groups

Dimensions of ICT Use	Stages of ICT Development	Target Groups
ICT as a tool for use across the curriculum or in separate subjects where the emphasis is on the development of ICT related skills, knowledge, processes and attitudes.	Minimum	Underpins all teaching practice in the same way as other literature
ICT as a tool for learning to enhance students' learning outcomes with the existing curriculum and existing learning processes.	Developmental	For beginning teachers and practicing teachers beginning to use ICTs
ICT as an integral component of broader curricular reforms that change not only how students learn but what they learn.	Innovator	For practicing teachers who are accomplished/highly accomplished users of ICT
ICT as an integral component of the reforms that alter the organization and structure of schooling itself.	Leader	For school and educational leaders and for teacher educators

The DEST (2002, p. 21) report notes that an accomplished teacher has the common attributes:

- A commitment to students and their learning;
- A deep knowledge and understanding of their subject discipline and of effective pedagogy;
- The ability to implement effective monitoring, assessment and reporting of student progress;
- A commitment to reflect critically on their own practice and to ongoing PD; and
- A willingness to contribute to the whole educational community at a range of levels.

Both DEST (2001; 2002) reports stress the need for underlying principles that should underpin the development of professional standards frameworks. These principles are based on what constitutes effective pedagogy, the effective use of ICT in schools, and research and experience from the development and implementation of other teacher standards frameworks. For example DEST (2002, p 31) suggests that any framework will assume the following.

- Acknowledging of the notion that teachers need time and support to develop competence;
- Assisting teachers to uncover their personal beliefs about teaching and learning;
- Encouraging teachers to describe their experiences with ICTs and the assumptions they have about ICTs;
- Assisting teachers to make the necessary curriculum links to effectively integrate ICT use in their classroom practice;
- Enabling teachers to assess their level of ICT competence and develop pathways to improve that competence;
- Addressing social justice issues such as access to professional development, access to appropriate resources, geographic isolation and ethnicity;
- For teachers supported simultaneously across a range of complementary initiatives including institutional capabilities, technological capacity, infrastructure capacity and policy support;
- Allowance for the development of standards based on a sound understanding of the complex nature of teachers' work;
- Support for the concept of learning communities that share ideas and experience;
- Link to, and provision for the focus of lifelong learning as part of the teachers' ongoing professional development;
- Consistent with student ICT standards;
- Complemented by ICT-rich student learning outcomes across all key learning areas;

- Cater for both Performance Management and Professional Development purposes;
- Supportive of a program to embed ICT rich descriptors and performance indicators in non-ICT specific professional standard frameworks; and
- Will have a limited life as a consequence of that embedding process.

Such a framework needs supporting capabilities such as policies and standards sustaining new learning environments, leadership, vision and support from the education system, and high quality professional development programs to ensure educators are competent in and have a high level of understanding of the effective use of ICT in teaching and learning. Along with these are ongoing financial support for sustained professional development and technology use, access to up-to-date technologies, software and high quality telecommunications network, technical assistance for maintaining this, appropriate curriculum design, timetables, teaching spaces and activities, quality curriculum resources, well articulated ICT-rich student learning outcomes for all curriculum areas, appropriate pedagogies supporting student-centred constructivist approaches to learning, and community partners who provide expertise, support and real-life interactions (DEST, 2002, p. 33).

Queensland: Information and Communications Technology Continua

A number of Australian states have developed frameworks for teachers. Of the most notable is the Education Queensland 2001 *Information and Communications Technology Continua* [draft] which has looked at developing continua to be used as a learning scaffolding tool to be used by teachers and other interested staff when developing personal learning and development plans that incorporate ICT. The development of the continua is an outcome of teacher requests for guidance beyond the minimum standards and to also recognise that many teachers are already operating at the various points along the continua. The continua's focus is on learning and teaching, not skills. Teachers are able to rate themselves in the four key areas of

1. Decision Making and Planning
2. Effective Learning and Teaching through the use of ICT
3. ICT & Curriculum inc. Classroom Planning & Management
4. ICT Knowledge, Skills, Processes and Attitudes

Education Queensland 2001 *Information and Communications Technology Continua* [draft] (<http://education.qld.gov.au/curriculum/learning/technology/cont.html>) are intended as learning scaffolds for teachers to access when developing personal learning and development plans that incorporate ICT. The matrix shows the **phases** and key **areas** of the continua for Decision Making and Planning; Effective Learning and Teaching through the use of ICT; ICT & Curriculum including Classroom Planning & Management; and ICT Knowledge, Skills, Processes and Attitudes. Teachers are asked to rate themselves under the levels of Minimum, Developmental, Innovator and Leader as achieved or working towards the level.

Tasmanian Resource Teacher (IRT) program

The Tasmania Education Department has provided support in the schools by introducing the In-school Resource Teacher (IRT) Program. This program was formulated to provide direct, in-time support to all teachers in the state system. The IRT program is based around five units and the delivery and assessment of these for all teachers. The IRT is responsible for running courses, workshops or conducting recognition of competence assessments. The units are:

- Unit 1 - Introducing basic computer concepts
- Unit 2 - Use of an application in an educational context
- Unit 3 - Internet and email use in the classroom
- Unit 4 - Multimedia and web page construction
- Unit 5 - Integrating ICT in the classroom / Online Teaching and learning and leadership

The IRT Program has now over 350 teachers qualified to run courses and make assessments in their schools. Their role is central to the success of developing a sound skills base in all schools. It will be even more important in developing a conceptual understanding of ICT integration as it is embedded into a teacher's program.

Aligning with the Western Australian Context

The Western Australian school system is now implementing an integration philosophy involving the infusion of ICT as a tool across the curriculum. This has impacted on the role of the classroom teacher, who needs inevitably to possess the skills to manage ICT in his/her classroom (DEETYA, 1999).

Competency Framework for Teachers

The Department of Education of Western Australia recognises that teachers are dedicated and committed to improving the educational outcomes for their students. Professional learning is seen as a key means of ensuring that teachers have the skills, knowledge and understandings necessary to provide students with high quality education (Martin, 2001). A Competency Framework for Teachers (http://www.eddept.wa.edu.au/centoff/cpr/Competency_Framework.pdf) was developed as a tool for Western Australian classroom teachers to:

- Reflect on their professional effectiveness
- Determine and prioritise areas for professional growth
- Identify professional development opportunities
- Assist their personal and career development planning.

The framework articulates the professional knowledge, skills and values essential for all classroom teachers, operating across three broad phases, under the five dimensions of *Facilitating Student Learning; Assessing Student Learning Outcomes; Engaging in Professional Learning; Participating in Curriculum Policy and Program Initiatives in an Outcomes-focused Environment; and Forming Partnerships within the School Community*. The competencies are generic and may be applied to specific teaching and learning contexts as defined by students, the learning areas, the school and the wider school community. The first three dimensions are perhaps the most pertinent to classroom teachers.

What the Competency Framework for Teachers does is provide an existing framework that can be built onto as suggested by the DEST (2002) report for the need of underlying principles underpinning the development of professional standards frameworks.

Table 11

Competency Framework for Teachers

	PHASE 1 Teachers operating within the first phase should:	PHASE 2 Teachers operating within the second phase should:	PHASE 3 Teachers operating within the third phase should:
DIMENSION 1 Facilitating Student Learning	Engage students in purposeful and appropriate learning experiences	Cater for diverse student learning styles and needs through consistent application of a wide range of teaching strategies	Use innovative and/or exemplary teaching strategies that are highly responsive and inclusive
DIMENSION 2 Assessing Student Learning Outcomes	Monitor, assess, record and report student learning outcomes	Apply comprehensive systems of assessment in determining student attainment of learning outcomes	Use innovative and/ or exemplary assessment strategies that are highly responsive and inclusive
DIMENSION 3 Engaging in Professional Learning	Reflect critically on professional experiences in order to enhance professional effectiveness	Contribute to the development of a learning community	Promote the development of a learning community
DIMENSION 4 Participating in Curriculum Policy and Program Initiatives in an Outcomes-focused Environment	Participate in curriculum policy and program teamwork	Provide support for curriculum policy or program teams	Contribute to the leadership of curriculum policy or program initiatives
DIMENSION 5 Forming Partnerships within the School Community	Establish partnerships with students, colleagues, parents and other caregivers	Support student learning through partnerships and teamwork with members of the school community	Facilitate quality teamwork within the school community

Source: *The Competency Framework for Teachers* (Martin, 2001, p. 4)

Framework for Implementation of LTs in WA Govt Schools

In 1998 the Education Department of WA released the “Framework for the Implementation of Learning Technologies in WA Government Schools” to support schools in the development of a learning technologies plan that was required to receive a government infrastructure grant. A copy of the framework is provided in Appendix C. The framework has six dimensions: *Planning, Integration and Use, Staff Capabilities, Electronic Educational Resources, Hardware, and Connectivity*. While these are all related to the implementation of ICT to support learning in schools, the latter two are not within the control of the individual classroom teacher and the fourth dimension is mainly connected with whole school management. Therefore, it is the first three dimensions to which any new framework should relate. Each dimension has a descriptor and pointers at four levels: Low, Mid, Target 2002, and High.

Planning

This dimension involves concerns for school planning for the integration of ICT use. Teachers usually have some input into school planning. It is stated that planning should integrate the use of ICT, link to student outcomes, and prepare for changing technology. At the HIGH level this is stated as,

Learning technologies planning is embedded in school curriculum plans, is well monitored and responsive to changing technology and emerging needs with the school.

The pointers at this level state that, Learning technologies planning is ...

... integrated in all learning areas and is embedded within curriculum and school planning processes.

... embedded in planning to improve student outcomes.

... monitored and flexible to take account of changing technology and emerging needs.

For an individual teacher the first two of these should be evident in their programme and lesson activity planning. It would be difficult for an individual teacher to plan for the third.

Integration and Use

This dimension involves concerns for the integration of ICT use in the teaching and learning programme. This is largely the teacher's domain. It is stated that integration should consider learning pedagogy, the pattern of student use of ICT, and the extent of use in teaching and learning programmes. At the HIGH level this is stated as,

A wide range of learning technologies are selected and incorporated into the teaching and learning program.

The pointers at this level state that,

Teachers facilitate interactive student-centred learning with emphasis on transforming knowledge using a wide range of learning technologies.

There is regular, individual and group use of learning technologies throughout the curriculum.

Teachers use a wide range of learning technologies in their teaching and learning program.

Clearly the emphasis is on creating constructivist learning environments that are consistent with international perspectives and educational research. There is a concern for quantitative (regular use) and qualitative (range) measures of the integration of ICT.

Staff Capabilities

This dimension involves concerns for staff skills in learning technologies. Once again this is mainly the concern of the individual teacher with school support. It is stated that this involves skills in operating learning technologies, applying the technologies to teaching and learning, and school planning for professional development. At the HIGH level this is stated as,

All staff have capabilities to use a wide range of appropriate learning technologies as an integral part of the teaching and learning program.

The pointers at this level state that,

Teachers are capable of confidently using a wide range of learning technologies and assist each other in developing their skills.

Teachers are innovative and able to identify enhanced ways of using learning technologies to their full potential in the teaching and learning program.

Staff professional development for learning technologies is an integral part of curriculum development and school planning.

Clearly the emphasis is on ICT operational, integration and implementation skills.

Supporting Teachers' Adoption of ICT

With any change come barriers to change. Computers have been in many classrooms for over two decades but several barriers have hindered wide use of technology by educators in the educational process. Helping educators change is the key to fostering ICT integration and some researchers have identified educational technology as a catalyst for bringing about educational change, particularly in shifting the teacher's role from one of lecturer (sage of the stage) to facilitator of learning (guide on the side) (Hinostroza & Mellor, 2000). Although many believe that despite new cognitive approaches to learning such as constructivism, education is stuck in the behavioural paradigm of the industrial age. While some teachers cope well with large-scale change, as they enjoy risk-taking and are willing to work with new methods of learning, many teachers are reluctant to change, as they cannot see the value in changing or adopting the new innovation. As Rogers (2000) states, understanding where teachers are in terms of their level of ICT adoption is a necessary step in understanding the barriers that prevent and the factors that influence adoption as each step requires different support and assistance.

Such barriers include the lack of funding or budget constraints, teacher training, limited time for teacher planning, lack of support and infrastructure, and lack of vision as to what can be achieved with technology, causing many educators to resist the change. Every educator looks at the integration of technology – and its challenges - from a different perspective. Rogers (2000) classifies the barriers into two categories: internal and external. Internal barriers come in the form of teacher attitudes or perceptions about technology in addition to the person's existing competencies in using these forms of technology. External factors encompass the availability and accessibility of the necessary hardware and software, the presence of technical personnel, institutional support and a staff development program that includes opportunities for skill acquisition and maintenance.

For ICT to be effectively adopted into schools, planning is vital. As a part of the planning process, the philosophy, aims, goals and objectives of the school must be used as a guide for the vision, goals and objectives of the technology program (Cole, 1999) with the main focus on the educational needs and skills of the students. Over a decade ago, school technology planning was heavily driven by the technologies, and most often in the form of equipment acquisitions, but today technology plans need to centre on the teaching and learning (Rogers, 2000). Ownership and collaboration with input from key stakeholders increase the potential for successful implementation of ICT into schools.

The chart shown in Figure 12 (Shortland-Jones, Alderson, & Baker, 2001) illustrates the process needed to help change occur. It is important to note that without the vision, appropriate skills, incentives, resources, an action plan and collegiality, change cannot occur without confusion, anxiety, resistance, frustration, or feeling like you are on a treadmill or isolated.

Vision	Skills	Incentives	Resources	Action Plan	Collegiality	Change
****	Skills	Incentives	Resources	Action Plan	Collegiality	Confusion
Vision	****	Incentives	Resource	Action plan	Collegiality	Anxiety
Vision	Skills	****	Resource	Action plan	Collegiality	Resistance
Vision	Skills	Incentives	****	Action plan	Collegiality	Frustration
Vision	Skills	Incentives	Resource	****	Collegiality	Treadmill
Vision	Skills	Incentives	Resource	Action plan	****	Isolation

Figure 12 Process required to help change.

Marcinkiewicz (1995) compared the levels of computer use by practising teachers with the expected levels of use by pre-service teachers. He found that almost all (97%) pre-service teachers expected to use computers in their classrooms, with 13.3% defined at the *Integration* level and 84% at the *Utilization* level. There was still a low number at the *Integration* level which he argued illustrated the current under-utilization of computers when compared with the expectations of pre-service teachers which approached an optimal level of computer use. Generally, the pre-service teachers had a higher locus of control (not found to correlate to use of computers) but a lower average computer experience.

Other predictor variables were similar between the groups. He concluded that the role of pre-service teachers as learners may be an important factor in their expectations of computer use and therefore practising teachers need to be encouraged to be learners.

Marcinkiewicz (1995) considered that the discrepancy between pre-service teachers and practising teachers indicated that either the future was brighter, or "it may indicate that future teachers' expectations of computer use will become lowered by external circumstances or those over which they have no control unless they are extraordinarily motivated" (p.194). He concluded that it was not more computers which were needed, but more support for teachers. Currently they expended their own time and effort to learn how to integrate computers into learning (Marcinkiewicz, 1994). However, Marcinkiewicz and Welliver (1993) pointed out that teachers, like any other profession with any innovation, would differ in whether they adopted computer use, including how long they took to adopt, and how they adopted.

Teachers make choices about computer support

It is difficult to explain the relationships involved in the implementation of computer support within a learning environment. A model setting out to explain these relationships must start with a consideration of the learning environment as previously discussed and shown diagrammatically in Figure 1. Research has shown that it is the actions of the teacher within the environment that are most critical when considering the use of computers. Usually it is the teacher who decides to use computers in a learning activity and even where the students own and control the computers, as in the case of one of Newhouse's (Newhouse, 1998) major studies, the teacher exerts such influence that all but a few students follow the teacher's explicit or implicit directions for the use of computers. An example of such a model is represented diagrammatically in Figure 15.

The degree to which teachers will facilitate the use of computers to support learning is determined by a balance of pressures or forces and the presence and size of barriers or obstacles to be overcome. The term forces indicates a resultant action and the term obstacles emphasises the removability. These concepts are represented in Figures 13 and 14 with the latter adapted from the PIT model of van Pelt & Vernooy-Gerritsen (van Pelt & Vernooy-Gerritsen, 1994).

When teachers experience forces (Figure 13), some may encourage them to facilitate computer use and others discourage facilitation of computer use. When combined they provide a resultant force that could be considered as a measure of the motivation and 'energy' level a teacher has towards facilitating computer support. The resultant force will determine the extent (both quantitatively and qualitatively) to which a teacher may be likely to implement computer support for learning under ideal circumstances and over a period of time. This extent or level of facilitation is represented by the 'energy level' plateaus in Figure 14. In order to achieve this level of facilitation there is usually a raft of obstacles to overcome, represented by the 'humps' before each level in Figure 14. This feature of the model diagram is designed to indicate that typically a teacher requires a greater level of motivation and energy to initially overcome the obstacles than to maintain a level of facilitation.

Forces are fundamentally perceptions in the 'mind' of the teacher that eventually influence actions. However, these perceptions may be based on external entities such as administrators, parents or students, or may be based on the internal beliefs of the teacher, or a combination of both. Some factors influencing teacher perceptions may be either positive or negative such as the perception of the requirements or nature of the curriculum. For example, one teacher may perceive their curriculum to require the use of computers to provide relevance while another may perceive the opposite based on the requirements of external assessment.

Obstacles are external to the teacher. They are those things that could be removed immediately by the actions of another person (although not necessarily) and as a result the teacher would facilitate a higher level of computer support for learning, closer to that indicated by the resultant force. For example, an obstacle may be lack of access to hardware or software. This would be removed if the school Principal bought more hardware or software. The lack of IT skills by the teacher or student may be an obstacle that could be removed by the purchase of easier to use software or the provision of a computer support teacher. A lack of time to experiment could be removed by providing a teacher with more time free of teaching. It is sometimes difficult to distinguish between negative forces and obstacles with both representing barriers to increased facilitation of computer support. A force change requires a change in the teacher while removing an obstacle does not. However, obstacles and their removal may have links to the teacher with, for example, a lack of IT skills not being an obstacle for highly computer literate teachers. So that an obstacle may be removed by long-term changes in the teacher but may also be removed immediately by the actions of other people without such changes.

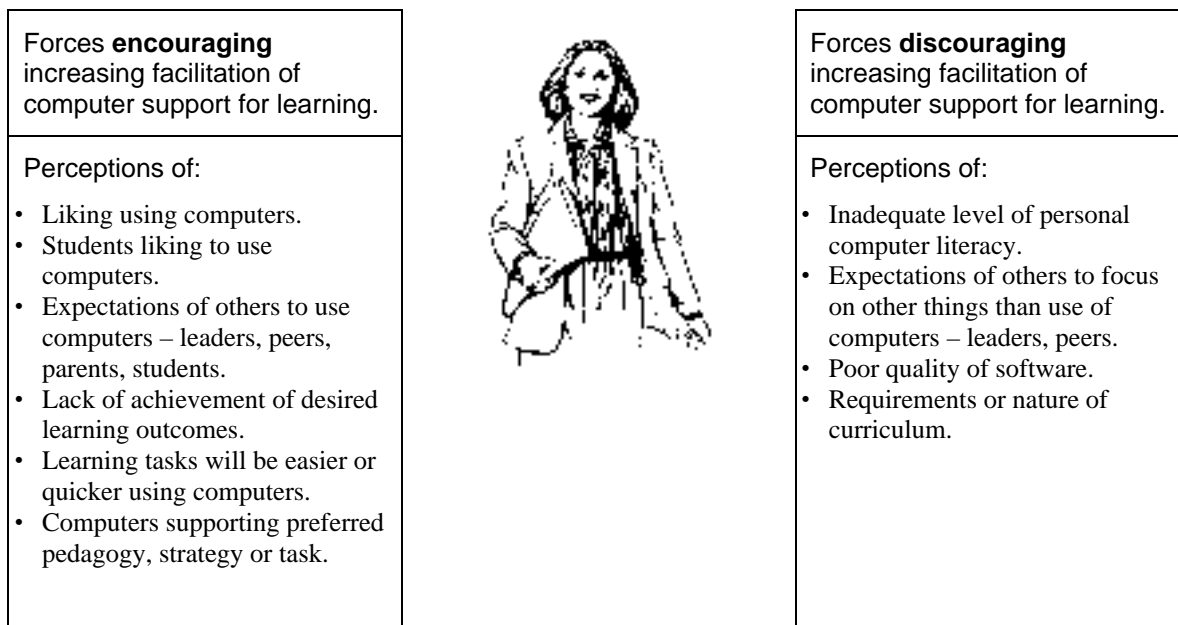


Figure 13 Some of the forces acting on teachers which may influence their facilitation of a level of use of computers in the classroom.

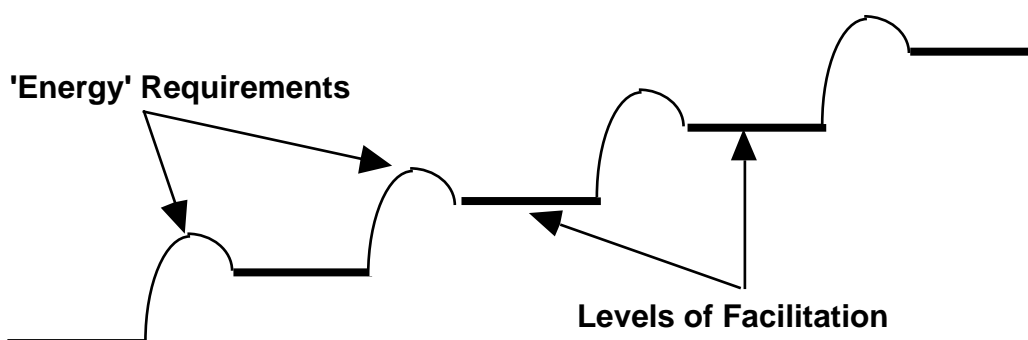


Figure 14 A diagrammatical representation of the concept of increasing levels of facilitation of computer support for learning requiring increasing levels of 'energy' from the teacher with an initial 'hump' (adapted from a model by van Pelt & Vernooy-Gerritsen, 1994, p. 9).

Central to the model explaining the level of facilitation of computer support for learning is the Type of Response (ToR) of the teacher to the opportunities to implement computer support (Figure 15). This is determined by the resultant forces acting within the teacher, which are influenced by the elements of the learning environment and entities external to this environment. While the ToR is an antecedent to the *Level of Facilitation* (LOF), it does not determine the level, as this is also dependent on the impact of obstacles to facilitation and the potential to remove these obstacles. The Level of Facilitation then has an impact on the learning environment as the technology is an interactive element of that environment. Thus a feedback loop is completed, providing the potential for successful facilitation to lead to increasing levels of facilitation.

It should be noted that the LOF of computer support for learning has both a quantitative and qualitative aspect. Quantitatively a higher level tends to indicate that computers are used more often to support a greater range of activities with a greater range of applications. Qualitatively a higher level indicates

that computer support is more embedded/integrated within the environment towards the aim of being critical to the successful functioning of a learning environment. This qualitative aspect is the more important aspect of the LoF.

It should also be noted that the LoF does not account for the measure of success of facilitation. Since the measure of success of facilitation is typically very subjective this is not included within the model. It is recognised that two experts in education could evaluate the success of facilitation for a particular environment in different ways and come to opposite conclusions. However, the LoF should be relatively easily determined since the quantitative aspect can be objectively measured and the qualitative aspect could be tested by observing (practically or theoretically) the effect of removing the computer support. Even so, the feedback loop within the model would suggest that successful facilitation, however this is represented, would encourage movement to higher levels of facilitation through the influence of the elements of the learning environment.

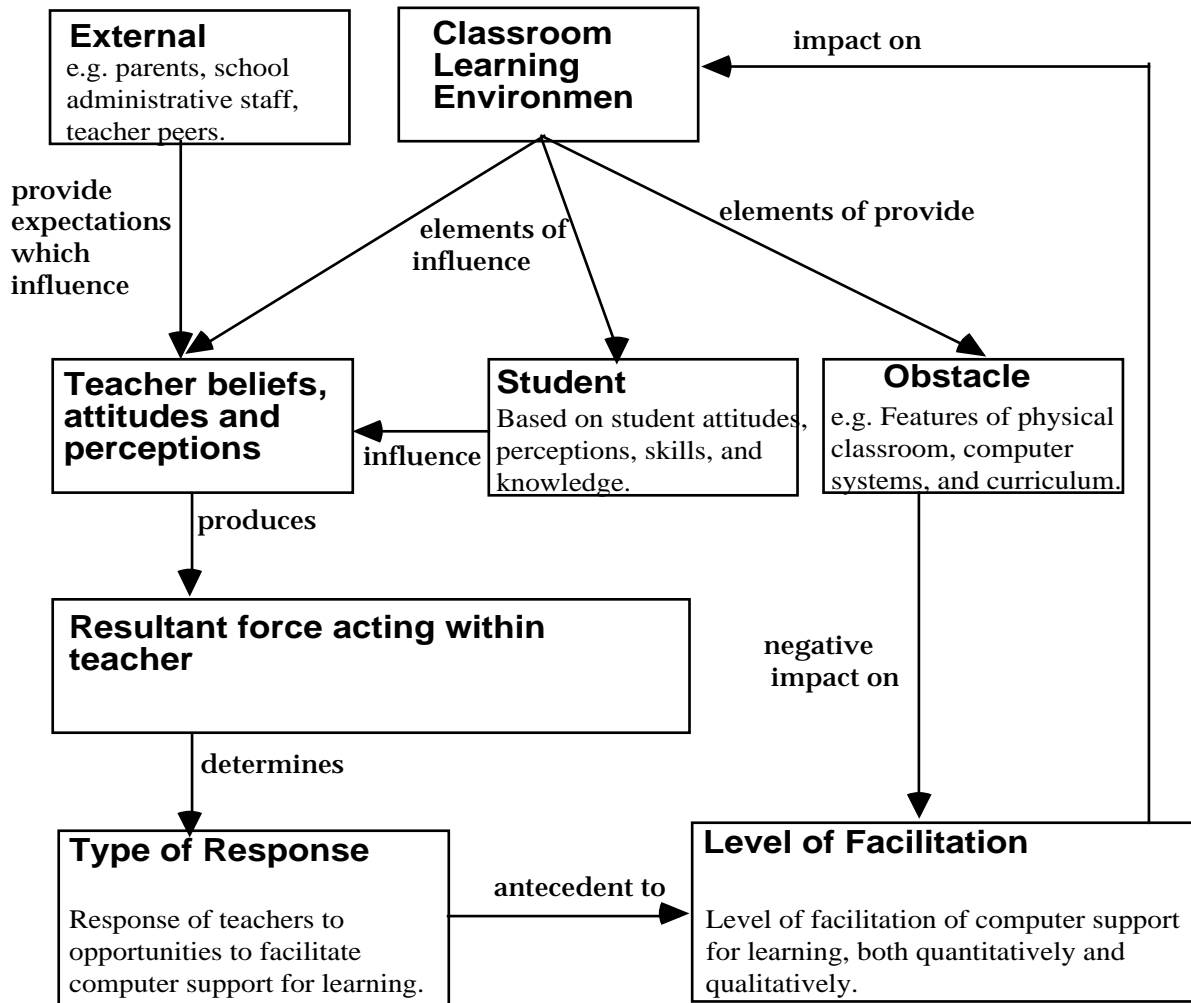


Figure 15 Diagrammatic representation of a model explaining the relationships involved in the implementation of computer support within a learning environment.

Professional Development Requirements

This section considers the professional development requirements of teachers to support them in progressing in their integration of ICT. These have implications for individual teachers, groups of teachers, schools and school systems that are addressed more fully in the companion document, *Framework for Implementation of ICT in Schools – Outcomes, Guidelines, Equipment and Processes* by Paul Newhouse, Sue Trinidad, and Barney Clarkson, December, 2002.

Helping Teachers to the Next Level

As schools are becoming 'technology rich' the successful use of ICT in classrooms is more than simply putting 'boxes on desks'. As longitudinal studies like the 10-year report on the Apple Classrooms of Tomorrow (ACOT, 1995) show, teachers must progress through a series of stages to instigate real change in their teaching style to adopt ICT into their classrooms. There is a need to 'make it easier for all teachers' to adapt to new learning environments and ways of doing things. It is also important to build 'communities' of learners who, through the infrastructure, can get help and 'just in time' professional development (Williams, 1998) to help in their journey of using technology.

It does take time for an educator to complete this journey and to develop a vision of what can be done with ICT. Very often this vision is developed first with the personal use of ICT, then further developed with appropriate professional development providing good models of best practice. These allow the teacher to further develop their vision and continue the journey necessary to integrate ICT fully into their classrooms. The necessary support and infrastructure must be in place to support such use.

When students play a more active role in the learning process, the educator's role must change. As educators begin to shift from being the dispenser of knowledge or the "sage on the stage" to a person who guides or facilitates the learning or the "guide on the side", such a facilitator of learning motivates the learner by setting up and supporting the appropriate learning environment in which to learn. To do this several assumptions must be considered. The first is that the learner can construct their own learning and the role of the educator is to assist the learner in this process. A second assumption is that learning extends beyond the storage of information and learners need to be able to analyse and synthesise information and become problem solvers. As educators become facilitators of learning and incorporate technology into their instructional strategies, they can progress through a number of stages. Several models have been discussed to explain the stages an educator must progress through to integrate technology effectively into their learning environments.

Without information about 'good practice' models to follow, it is often hard to implement ICT realistically into the workplace. When educators are asked to adopt new teaching combinations involving technology, they are being asked a lot. Most are busy people who may not have observed others teach effectively using technology. It is unrealistic to expect any human being to replace quickly, easily and without help, habitual behaviours based on years of using the same teaching. When the requested new behaviours are only described not modelled, a major commitment of time and energy is needed. Asking someone who has become a successful professional teacher to adopt new ways of teaching is to ask that person to return to a subordinate, insecure, learning role. *The support and incentives need to be good for educators to want to change!* There must be time for an educator to complete this journey and to develop a vision, 'good practice' models, necessary support and infrastructure and incentives to change.

Developing and Supporting Educators' Visions to Use ICT

Users of any technology can fall into one of five groups, as shown in Figure 15 based on Roger's (1995) work on the diffusion of innovations. People who grasp the technology immediately are known as the *Innovators* (2.5%). They are the very small percentage of users who are always up-to-date with the latest technology and experimenting with future technologies. *Early Adopters* (13.5%) make up the next group and these people readily use technology also although maybe not immediately: they wait, watch then go with the technology adoption.

The majority of people fit into the next two groups, the *Early Majority* (34%) and the *Late Majority* (34%). Providing both groups are provided with models of best practice, support and the necessary infrastructure to use the technology, then these groups will move towards using the technology as long as they can see a purpose or reason to use the technology.

The final group the *Laggards* (16%) is the group that usually will not change their ways so it is not worth wasting energy on this group of people.

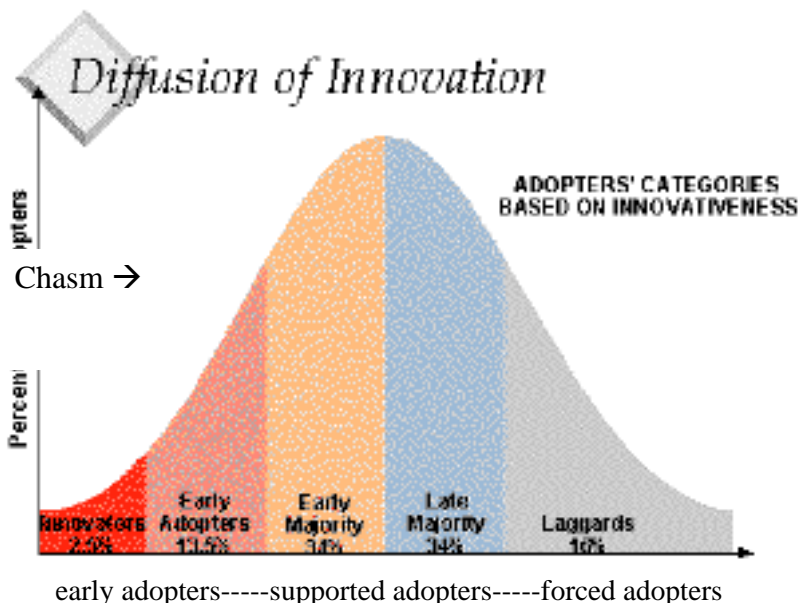


Figure 16: Rogers (1995) Diffusion of an Innovation

There can be a chasm between the 'early adopters' and 'early majority' – a chasm which has potentially harmful consequences for innovations like using ICT in teaching and learning. One of the reasons that many teachers balk at crossing the chasm and balk at the prospect of the innovation is the fear of not covering the content. Teachers who have not had a chance to develop a vision of what can be done with the technologies or view models of how curriculum can be enhanced with the use of ICT cling to the 'content' and resist moving on their journey because it is 'not easy' to change. Technologies may be resisted by educators because they are incompatible with their philosophy of teaching and the daily realities of the classroom. Many early educational technologies required teachers to relinquish control of the content and presentation while the technology was running. Teachers needed to stop teaching, and students were generally unable to ask questions or have information repeated during the instructional delivery. Such materials are designed to be teacher-proof, teachers typically receiving no training or inappropriate training, focused only on the technical aspects of using the technology. The keys to successful professional development and the necessary support needed to help educators use ICT have been documented through two Northern American reports described below.

In schools across Canada there are several innovative programs demonstrating how technology can enhance student learning. Issues such as access, connectivity, lack of content and technical support continue as obstacles, however, it is clear that effective professional development of teachers is the key to widespread and effective integration of technology into classrooms. The primary focus of professional development programs for teachers has shifted from learning technology skills to how technology can be used as a tool to enhance teaching and learning. This Canadian report for the Schoolnet National Advisory Board (Laferrière et. al., 1999) illustrates many of the wonderful professional development models used across Canada to support the use of ICT in schools and classrooms. These types of professional development or combinations of such may be used:

Action Research: This is where teachers are teamed with university education staff and students, sometimes as part of accreditation courses, to investigate new models of ICT and share their finding in action research projects.

Cascading: This is where the lead teachers from a group of schools receive intensive training and become part of an ongoing professional development network enabling them to return to their schools to provide ongoing on-site support to their colleagues.

Collaborative Learning Projects: This is where the teacher and student teachers develop their ICT skills and knowledge by working with colleagues and students' online collaborative projects.

Mentoring: This is where a central team of highly skilled and knowledgeable mentors work directly with teachers in classrooms and follow up with ongoing online mentoring.

Networks: This is where a virtual centre is created as a place for teachers to access digital resources and to participate in professional dialogue with colleagues.

A Teacher Centre: This is where a resource centre is established to provide workshops modelling best practice, learning resources and access to consultants' expertise. The centre is often complemented by an online component. (taken from Laferrière et. al., 1999, online)

Such types of professional development or combinations of such give educators the necessary support, infrastructure and networking to help them develop their teaching styles when using ICT. Similarly, the ACOT report (1995, p19) documents "*Characteristics of Successful Staff Development*" used at the ACOT Teacher Development Centres:

Constructivist learning environment - ACOT Teacher Development Centers model a learner-centered environment allowing teachers to take advantage of the opportunity to experience how their students might learn while constructing their own knowledge. Teachers learn about the role of technology in instruction while experiencing a constructivist learning environment.

Situated staff development - Working in real classrooms with real students makes staff development participants better able to see that what they are learning can be useful in their own classrooms. The classroom observations not only provide participants with models of teaching strategies, new ideas, and validation for what they were already doing, they also stimulate discussions of educational issues.

Time for reflection - When teachers experience a different kind of learning environment, such as that found in the ACOT Teacher Development Centers, they need time to think about the new information they're getting. Personal reflection, while participating in a group discussion or writing in a personal journal, helps teachers to question their own beliefs and to begin the process of change.

Specific plans for change - To structure their observations and experiences, and to facilitate the transfer of new ideas into their own classrooms, participants at the ACOT Teacher Development Centers plan a project that they will implement upon returning to their schools. The major purpose of the project is to get teachers to use their existing resources.

Immediate and ongoing follow-up support - As new skills need to be reinforced with practice and supported with feedback, the teacher development program includes a two-part follow-up component. First, the centers require that teachers attend in teams, so they can provide each other with both practical and emotional support when they return to their schools. In addition, the project coordinators provide frequent feedback to the participants about the implementation of their projects, and they encourage an ongoing conversation about instructional change.

Whatever the approach, professional development programmes are more likely to succeed if they include some of the following features:

- The inclusion of teachers in the design of their own learning.
- Using a mix of types of interaction and learning styles (face-to-face workshops, online discussion and mentoring, multimedia presentations) that model effective teaching.
- Providing objectives that are achievable given the access to technology and support available in the teachers' classrooms and in school laboratories.
- Opportunities for online interaction and collaboration among teachers as part of a PD network to explore questions and to share resources and ideas.
- Access to expertise, information and resources consistent with the required curriculum.
- Development of a school and school district culture that supports innovation and change.
- Partnerships and collaboration among schools, school districts and faculties of education to share resources and build a critical mass of participants.
- Sustained support from the school, the school district and the community and their commitment to technology as a long-term priority.
- Opportunities for teachers to innovate and engage in collaborative action research.
- Long-term transitional approaches that include a variety of follow-up activities.
- Ongoing monitoring and assessment of success.

The companion document, *Framework for Implementation of ICT in Schools – Outcomes, Guidelines, Equipment and Processes* by Paul Newhouse, Sue Trinidad, and Barney Clarkson, December, 2002, addresses many of these issues.

Glossary of Terms & Acronyms

Computer system	Combination of hardware, software and personnel.
Constructivism	A theory to explain how people learn by making meaning of the experiences they have in the environment they inhabit.
Curriculum	The content (information and processes) that students are required to engage with and the medium used to engage with the content.
Educational Technology	The use of any technology to support the processes of teaching and learning.
Hardware	The tangible components of a computer system.
HTTP	The protocol (set of rules for communication) used by the World Wide Web. Stands for: Hypertext Transfer Protocol
ICT	Information and Communications Technologies
Internet	The interconnection of networks using the TCP/IP common protocol (set of rules for communication).
IT	Information Technologies
Learning Technologies (LTs)	The use of any technology to support the processes of teaching and learning. However, in WA this has come to mean the use of ICT to support these processes.
PD	Professional Development
PDF	A format of document files often used for documents to be transferred over the internet. Referred to as Adobe Acrobat files and stands for: Personal Document Format.
Pedagogy	The processes of teaching, particularly where the learners are children.
Server	A computer used to provide services to a computer network. Examples are web servers and email servers.
Software	The electronic instruction files used by computer systems to complete tasks for a user (person).
TCP/IP	The protocol (set of rules for communication) used by the Internet. Stands for: Telecommunications Protocol/Internet Protocol
URL	The address of a file to be accessed over a network using protocols such as HTTP. Stands for: Universal Resource Locator

APPENDICES

- Appendix A: Concerns Based Adoption Model (CBAM)**
- Appendix B: Professional Competency Continuum (Milken Technology Exchange)**
- Appendix C: A Framework for the Implementation of Learning Technologies in WA
Government Schools**

APPENDIX A: Concerns Based Adoption Model (CBAM)

Innovation Configuration Components and Variations for Computers Supporting Learning. (Adapted from Newhouse, 1998)

1. Access to computers			
(1) All students have computer access available at all times.	(2) All students have access to a computer at home and sometimes at school.	(3) Some students have computers at home.	
2. Student use of computers in a subject area			
(1) Students use computers at home and in many lessons, where appropriate.	(2) Students use computers at home and in some lessons.	(3) Students use computers at home.	(4) Students do not use computers for subject.
3. Classroom organisation			
(1) Teacher uses a variety of teaching strategies based on computer use.	(2) Teacher uses one alternative teaching strategy based on computer use.	(3) Teacher uses no alternative teaching strategies based on computer use.	
4. Independent learning			
(1) Students use computers extensively to support working at their own pace and constructing their own knowledge.	(2) Students sometimes use computers to support working at their own pace and constructing their own knowledge.	(3) Students never use computers to support working at their own pace and constructing their own knowledge.	
5. Teacher-student relationship.			
(1) Students do not depend on teacher for knowledge acquisition or completion of tasks on the computer.	(2) Students often do not depend on teacher for knowledge acquisition or completion of tasks on the computer.	(3) Students depend on teacher for knowledge acquisition or completion of tasks on the computer.	
6. Learning Activities.			
(1) Students use computers to complete practical or investigative activities which are relevant to their experience. The activities will be designed to develop both higher and lower order learning skills.	(2) Students use computers to complete practical activities which are relevant to their experience.	(3) Students use computers to complete activities which are not always relevant to their experience but may be either practical or investigative in nature.	
7. Nature of task environment.			
(1) Students will be given tasks to complete on the computer which are motivating and problem solving and students will receive regular feedback on those tasks.	(2) Students will be given tasks to complete on the computer which are motivating and students will receive regular feedback on those tasks.	(3) Students will be given tasks to complete on the computer which may be motivating but students do not receive regular feedback on those tasks.	

8. Technological literacy.

(1)	(2)	(3)
Students develop a level of technological literacy relevant to school and entry level workplaces through the use of the computers. Students will improve the presentation of their work and use the drafting cycle.	Students develop a level of technological literacy relevant to school through the use of the computers. Students will improve the presentation of their work and use the drafting cycle.	Students will improve the presentation of their work and use the drafting cycle.

Stages of ConcernDescription of the CBAM Stages of Concern (SoC) (Hall, George, & Rutherford, 1986).

Stage	Description
0 Awareness	Little concern about or involvement with the innovation is indicated.
1 Informational	A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about herself/himself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.
2 Personal	Individual is uncertain about the demands of the innovation, her/his inadequacy to meet those demands, and her/his role with the innovation. This includes analysis of her/his role in relation to the reward structure of the organisation, decision making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
3 Management	Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organising, managing, scheduling and time demands are utmost.
4 Consequence	Attention focuses on impact of the innovation on students in her/his immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.
5 Collaboration	The focus is on coordination and cooperation with others regarding use of the innovation.
6 Refocussing	The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.

Levels of Use

Description of the CBAM Levels of Use (LoU) (Hall, Loucks, Rutherford, & Newlove, 1975).

Level	Description
0 Non-Use	State in which the user has little or no knowledge of the innovation, no involvement with the innovation, and is doing nothing toward becoming involved.
I Orientation	State in which the user has acquired or is acquiring information about the innovation and/or has explored or is exploring its value orientation and its demands upon user and user system.
II Preparation	State in which the user is preparing for first use of the innovation.
III Mechanical Use	State in which the user focuses most effort on the short-term, day-to-day use of the innovation with little time for reflection. Changes in use are made more to meet user needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks required to use the innovation, often resulting in disjointed and superficial use.
IVA Routine	Use of the innovation is stabilised. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.
IVB Refinement	State in which the user varies the use of the innovation to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of both short-term and long-term consequences for clients.
V Integration	State in which the user is combining own efforts to use the innovation with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence.
VI Renewal	State in which the user re-evaluates the quality of use of the innovation, seeks major modifications of or alternatives to present innovation to achieve increased impact on clients, examines new developments in the field, and explores new goals for self and the system.

APPENDIX B: Professional Competency Continuum (Milken Technology Exchange)

Technology in American Schools: Seven Dimensions for Gauging Progress. Milken Exchange on Educational Technology (**paraphrased in places**)

Core Technology Skills			
	Entry	Adaptation	Transformation
Hardware/Computer	Starting, ending, using basic software apps and making simple connections.	Understands and uses management functions of OS. Peripherals connected. Troubleshoots to seek assistance.	Use of computers and peripherals has become transparent. Keeps up-to-date for purchase decisions. Transfers skills.
Hardware/Other	Aware of technologies but lacks either the skill or access to use them.	Uses relevant technologies (MIDI, graphics calculators). Support existing instruction.	Uses technology throughout the curriculum, often in unique and creative ways. May alter strategies and seek new technologies.
Applications	Mainly uses WP, perhaps email. Aware of other apps. Inefficient use.	Comfortable with a host of applications. Integrates use of basic apps but may be proficient in others.	Sophisticated user of apps. Develops skill using JT resources. Cross-apply skills. A resource to other educators.
Information Tools	Knows how to browse the WWW but not with efficient search skills. Email used for local communication.	Understands and uses efficient search methods. Understands variety of online resources and creates lessons with them.	Use of information tools is central to professional life. Conducts research, evaluates information and guides others.
Network Tools	Uses email. Uses correct terminology for network components but little conceptual base. Uses file server.	Navigates network environments to find resources. Uses collaborative network software. Solves network problems.	Uses network resources transparently as an integral part of everyday teaching. Contacts experts and primary resources.
MM/Presentation Tools	Aware of MM/presentation and assessment tools. May use one tool.	Uses a variety of tools and peripherals to create MM presentations. Most student projects are computer-based.	Uses a variety of tools and learns new ones easily. Familiar with MM file formats. Guides students in applying to audiences.
Curriculum, Learning and Assessment			
Curriculum	Aware of the value of ICT but tends to use as a reward or end in itself. may be used out of context, in a lab and with an expert.	Regularly applies technology that supports the existing curriculum standards. Tend to reflect current instructional strategies and content.	Skilled at involving students in developing ICT-enriched activities that are multi-disciplinary. Strategies are efficient/engaging.

Teaching/Learning Strategies	Highly teacher-centred and often non-interactive. Subject specific non-authentic tasks done individually.	Active, project-based learning but not for audience. Technology used to make more engaging existing instruction	Technology woven into many multidisciplinary situations to create a learning community. Construct meaning
New Roles for Educators	Teacher directs for transmission of information. Experiments with some student direction.	Uses facilitation strategies. Allows increased student independence but within classroom experience.	Acts primarily as a facilitator allowing for construction of meaning through modelling, mediating, explaining etc.
New Roles for Students	Little ownership but collaboration allowed under controlled situations.	Students work collaboratively and independently. Simulated roles.	Students explore new ideas based on interest and curriculum. Independent producers of knowledge for others.
Assessment	Summative pen and paper assessments. Limited use of portfolios.	Assessment is viewed as an integral part of instruction. Portfolios, rubrics etc.	Assessment is viewed by students as an integral and valuable part of learning.
Professional Practice			
Technology for Professional Productivity	Preliminary attempts to integrate technology, inefficient.	Regularly applies technology to professional productivity.	Range of technologies used for high level discourse with sources of expertise.
Collaborations	Aware of potential but only uses non-electronic collaboration.	Uses several collaborative technologies to automate previous practice.	Initiates online collaborations and develops resources with peers/experts.
Communications	Mainly paper-based.	Technology indispensable to communications in school community.	Technology has transformed communications throughout the school.
Professional Resources	Aware of ed tech associations, conferences and publications.	Accesses online and print resources. Attends ed tech conferences.	Contributes to resources for others.
Resource Acquisitions	Uses resources but doesn't procure.	Acquires technology resources.	Identifies/acquires resources for others.
Classroom and Instructional Management			
Organisation and Use	Technology only used in highly structured fashion. Directed by "computer teacher".	Skilled at organising technology resources in support of existing practice. More group and independent work.	Organisation is a shared responsibility with students. Use technology resources with minimal teacher direction.
Access and Location	Mainly use laboratories. Classroom computer used as "filter".	Technology closer to point of instruction. Teacher supervision.	Learning environment with efficient & convenient access to ICT resources.
Instructional Management	Aware of management software.	Uses management software to support existing practice.	Uses a range of self-designed and sophisticated management software.
Administrative Competencies			
Modelling Effective Use	Clerical staff use technology.	Uses basic admin technologies.	Excellent role model in use of technology
Leading Professional	Relies on district staff and interested teachers	Takes active role in facilitating technology PD	Considers tech PD to be critical and a school-

Development	for software training.	of staff.	wide initiative.
Leading/Managing Systemic Change	Familiar with system change theory but can not lead the process.	Engages staff in system change.	Creates a community where experimentation is valued etc.
Maintaining a Knowledge Base	Accepts any use of technology. Aware of existence of literature.	Working knowledge of effective practices using technology. No strategy for staying abreast of developments.	Well-versed in knowledge base and is able to constructively evaluate classroom uses of technology.

APPENDIX C: Framework for the Implementation of Learning Technologies in WA Government Schools

The framework was developed by the Education Department of Western Australia (now W.A. Department of Education) and may be downloaded from their web-site. A copy of the framework is provided on the next page.



LEARNING
Technologies

A Framework for Implementation of Learning Technologies in WA Government Schools

PLANNING

INTEGRATION & USE

STAFF CAPABILITIES

ELECTRONIC EDUCATIONAL RESOURCES

HARDWARE

CONNECTIVITY

PLANNING	INTEGRATION & USE	STAFF CAPABILITIES	ELECTRONIC EDUCATIONAL RESOURCES	HARDWARE	CONNECTIVITY
<p>Integration in school planning</p> <p>At a Glance</p> <p>Pointers</p> <ul style="list-style-type: none"> Level of integration of learning technologies in curriculum planning Planning linked to student outcomes. Planning for changing technology. 	<p>Learning technologies in the teaching & learning program</p> <p>At a Glance</p> <p>Pointers</p> <ul style="list-style-type: none"> Learning pedagogy. Pattern of student use. Extent of use in teaching and learning programs. 	<p>Staff skills in learning technologies</p> <p>At a Glance</p> <p>Pointers</p> <ul style="list-style-type: none"> Teachers facilitate interactive student-centred learning with emphasis on transforming knowledge using a wide range of learning technologies. There is regular, individual and group use of learning technologies throughout the curriculum. Teachers use a wide range of learning technologies in their teaching and learning program. 	<p>Review and management of software resources including Internet sites</p> <p>At a Glance</p> <p>Pointers</p> <ul style="list-style-type: none"> Learning technology skills. Application to teaching and learning. School planning for professional development in learning technologies. 	<p>Provision and management of hardware resources</p> <p>At a Glance</p> <p>Pointers</p> <ul style="list-style-type: none"> Selection and acquisition of electronic educational resources. Organisation and management of electronic resources. Teacher use in teaching and learning program. 	<p>Internet & network connections</p> <p>At a Glance</p> <p>Pointers</p> <ul style="list-style-type: none"> Process of management of connections. Network services available throughout the school. Extent of networking and Internet access.
<p>Learning technologies planning is embedded in school curriculum plans, is well monitored and responsive to changing technology and emerging needs within the school.</p>	<p>A wide range of learning technologies are selected and incorporated into the teaching and learning program.</p>	<p>All staff have capabilities to use a wide range of appropriate learning technologies as an integral part of the teaching and learning program.</p>	<p>Planned approach to management and use of electronic educational resources appropriate to the teaching and learning program.</p>	<p>The school has excellent facilities which allow for varied modes of usage to maximise improvement in student learning. Effective policies and procedures for the management of hardware resources are evident.</p>	<p>High standard connections and integrated use within the curriculum.</p>
<p>Learning technologies planning is integrated in all learning areas and is embedded within curriculum and school planning processes.</p> <ul style="list-style-type: none"> Learning technologies planning is embedded in planning to improve student outcomes. Learning technologies planning is monitored and flexible to take account of changing technology and emerging needs. 	<p>Teachers facilitate interactive student-centred learning with emphasis on transforming knowledge using a wide range of learning technologies.</p> <ul style="list-style-type: none"> There is regular, individual and group use of learning technologies throughout the curriculum. Teachers use a wide range of learning technologies in their teaching and learning program. 	<p>Teachers are capable of confidently using a wide range of learning technologies and assist each other in developing their skills.</p> <ul style="list-style-type: none"> Teachers are innovative and able to identify enhanced ways of using learning technologies to their full potential in the teaching and learning program. Staff professional development for learning technologies is an integral part of curriculum development and school planning. 	<p>Selection of electronic resources is coordinated throughout the school and strongly linked to the curriculum needs of students and staff for all learning areas.</p> <ul style="list-style-type: none"> There is management and coordination of all electronic resources across all learning areas. All staff are confident in their selection and appraisal of electronic resources for the teaching and learning program. 	<p>Computer to student ratio: primary 1:1, secondary 1:1. Extensive variety of learning technologies for different curriculum needs in all learning areas.</p> <ul style="list-style-type: none"> Students have unlimited access to select and use learning technologies. Technical support and maintenance is well managed by skilled experts from a technical support contact or school appointed technician. A planned and dynamic learning technologies repair and replacement program is in place. 	<p>Management plan for the operation of learning technologies networks across the school is being developed.</p> <ul style="list-style-type: none"> Reasonable range of online services available throughout the school (eg: Internet access, within school e-mailing and shared curriculum resources). A curriculum LAN connecting most teaching and learning areas in the school providing adequate access to the Internet.
<p>Learning technologies planning is developed in most curriculum plans.</p> <ul style="list-style-type: none"> Learning technologies planning takes account of, and is responsive to, student outcomes. Learning technologies planning is developing to take account of changing technology. 	<p>Learning programs regularly incorporate learning technologies across most learning areas.</p>	<p>Most staff regularly use a range of learning technologies and are integrating these into the teaching and learning program.</p>	<p>Planned approach to management of electronic educational resources. Use of electronic educational resources is appropriate to the teaching and learning program.</p>	<p>Provision of learning technologies is adequate to facilitate daily use by all students in most learning areas. There is a planned approach to future hardware requirements.</p>	<p>Connections adequate to curriculum demands.</p>
<p>Learning technologies planning is either a separate plan or integrated within curriculum plans.</p> <ul style="list-style-type: none"> Learning technologies planning has some links to student outcomes. Planning is according to the principles in the Learning Technologies Planning Guide. 	<p>Learning programs incorporate learning technologies on a limited basis.</p>	<p>Most staff have basic learning technologies operational skills and are beginning to apply these to the teaching and learning program.</p>	<p>A planned approach to management and use of electronic educational resources is developing with emerging links to the teaching and learning program.</p>	<p>Level of hardware provision allows for increased flexibility and use of learning technologies. Planning and management for learning technologies is emerging.</p>	<p>Connectivity has expanded to meet limited curriculum demands.</p>
<p>Learning technologies planning is in its initial stages.</p> <ul style="list-style-type: none"> Most probably a separate plan with few links to student outcomes in curriculum plans. Linking of learning technologies planning and improvement in student outcomes is yet to occur. Learning technologies planning in its initial stages within the context of the Learning Technologies Planning Guide. 	<p>Teachers accept that learning technologies can improve student outcomes but are yet to implement them in the teaching and learning program.</p>	<p>Staff developing minimal basic learning technologies skills on an individual basis. Development of these skills is largely unplanned.</p>	<p>No planned approach to electronic educational resources management.</p>	<p>Level of hardware provides limited usage and flexibility. Procedures for management for learning technologies resources are ad hoc and inconsistent.</p>	<p>Connectivity is limited with minimal use in the teaching and learning program.</p>

LEVEL OF IMPLEMENTATION

LOW

MID

TARGET 2002

HIGH



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