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A Framework for Leading School Change in using ICT: Measuring Change

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Abstract: *Over the last three decades many models explain the processes involved in the adoption and use of ICT in education. Based on this literature, a three-tiered framework and associated instruments were developed to use with Western Australian teachers to measure and support change in using ICT. This framework can be used to support, describe and promote good practice in the use of ICT in learning and teaching in schools and is multi-faceted and flexible enough to be used by individuals, groups, schools or educational organizations. The aims and purposes of the framework were to describe quality pedagogy in the use of ICT to effectively support student learning in schools; to assist teachers in planning to integrate ICT into learning environments; to describe progress by teachers as they move towards the integration of ICT in quality pedagogy; to assist teachers in the development of their own practice in the use of ICT to support student learning; and to provide a tool for teacher dialogue for ICT integration with good pedagogy and provide topics or questions that describe concerns teachers may have. This framework was based on a review of the literature on the progression of teachers in their integration of ICT in learning and teaching processes. It was positioned within a broader framework for the implementation of ICT in schools to connect with students, learning environments, school and system organisations. This paper describes the process and results from this research undertaken to develop the framework for schools and teachers.*

Background and Purpose

When making decisions about the use of ICT 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. While policy documents mandate the use of ICT in education 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.

The authors undertook to develop a framework that would support, describe and promote good practice in the use of ICT in learning and teaching in schools. The ICT framework produced needed to be multi-faceted and flexible enough to be used by individuals, groups, schools or educational organizations. The aim was to describe the characteristics of effective learning and quality pedagogy as they relate to ICT integration; and the stages of progress by teachers as they move towards ICT integration in quality pedagogy.

The aims and purposes of the ICT framework were to:

1) Describe quality pedagogy in the use of ICT to effectively support student learning in schools.
2) Assist teachers in planning to integrate ICT into learning environments.
3) Describe progress by teachers as they move towards the integration of ICT in quality pedagogy.
4) Assist teachers in the development of their own practice in the use of ICT to support student learning.
5) Provide a tool for teacher dialogue for ICT integration with good pedagogy and provide topics or questions that describe concerns teachers may have.

Literature Review

The framework was constructed after reviewing previous models of ICT adoption. It seemed useful to classify these models on two characteristics, namely the scope of the target group they address, and the relevance of an individual's learning. Four classifications, namely the *Population*

Models, *System/School Models*, *ICT–Orientated Micro Models* and the *Learning Micro Models* evolved and are given in Table 1.

Classification	*Example Models of ICT Adoption*
Learning Micro Models	• **CBAM** ***-Levels of Use (LoU)*** ***-Stages of Concern (SoC)*** ***-Innovation Configuration*** • **ADL model of ICT Uptake**
ICT-Oriented Micro Models	• **Instructional Transformation Model** • **ACOT model** • **LoT implementation**
System/School Models	• **Milken's 7 Dimensions for Gauging Progress** • **NETS** • **Technology Maturity Model (TMM)**
Population Models	• **Diffusion of Innovation model (DoI)**

Table 1: Four Classifications of the Models of ICT Adoption

These four classifications and examples are discussed here as part of the literature reviewed to develop the framework.

The Learning Micro Models

In the 1990s, several major research efforts (e.g. Cicchelli & Baecher, 1990; Collis, 1994; Marcinkiewicz, 1994; Rieber & Welliver,1989; Sandholtz et al., 1992) began to develop and apply models for investigating the implementation of computers in classrooms in various parts of the world. Many of these are based on teachers' concerns about innovations, and are often called concerns-based models (CBAM). The application of CBAM, or models based upon CBAM, to research concerned with the use of computers in classrooms, has gained interest throughout the world. Most interest appears to be with the *Levels of Use* (LoU) and *Stages of Concern* (SoC) dimensions (i.e. user focus) (Marsh, 1988). Recently there has been more interest in including an *Innovation Configuration* (i.e. innovation focus). This is the basis of many of the frameworks being developed. Two of the few researchers to apply all three dimensions to a study were Carbines (1986) and Hope (1995), who considered the use of computers in primary school classes. A number of smaller studies have also been reported (Cicchelli & Baecher, 1990; Overbaugh & Reed, 1995) while some of the researchers in Europe (e.g. Vernooy-Gerritsen, 1994) and USA (e.g. Marcinkiewicz & Welliver, 1993) have worked at modifying the SoC and LoU to describe the use of computers in classrooms by teachers. Some (e.g. Moersch, 1997) have attempted to construct instruments to measure the LoU of ICT by 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 these appear to have difficulty in capturing 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.

Another example of a learning micro model is the ADL model of ICT Uptake (Clarkson & Oliver, 2002). The principle aim of the research giving rise to the ADL model (which stands for Autonomy, Dependence and Learning) 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. 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 being reliant on previous research. The model describes four stages: Dependence, Counter-Dependence, Independence and Interdependence.

These stages reflect typical phases through which all learners pass when they achieve mastery on any new topic they are learning. ICT is simply another topic for learners to master, in this less technocentric conception of ICT uptake as a learning issue. It was named the ADL uptake model in an attempt to capture the role of Autonomy, Dependence and Learning in the ICT uptake process.

An extended version of the stages approach was developed and validated by Clarkson & Oliver (2002), which utilises a 4 x 3 table with four stages of teacher development and three characteristics at each stage, namely intellectual, attitudinal and performance. 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 1) with cells defining the basic layout. Each cell had descriptors and indicators of feelings, understandings and behaviours which teachers were able to fill in. The increased level of sophistication of models such as this reflects the need to accommodate more than teachers in isolation.

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

Figure 1: Four stages of ICT uptake as proposed in the ADL uptake model.

The ICT – Oriented Micro Models

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. 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. These steps are described in Table 2 and compared with equivalent steps developed for the Apple Classrooms of Tomorrow (ACOT, 1995) project.

These stage that an educator must progress through correspond to the ACOT stages where there is 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. These stages are confirmed in long-term projects like the Apple Classrooms of Tomorrow (ACOT, 1995) studies which show that teachers must travel through a number of stages to integrate ICT fully into their classrooms and their teaching programs (see Table 2) and teachers

must progress through all five phases, otherwise, the technology will likely be misused or discarded (Rieber & Welliver, 1989; Marcinkiewicz, 1994).

Welliver Instructional Transformation Model	ACOT Model
Familiarisation Is when the teacher becomes aware of technology and its importance	**Entry** Learn the basics of using the new technology
Utilisation Is when teachers use technology, but minor problems will cause teachers to discontinue use	**Adoption** Use new technology to support traditional instruction
Integration Is when technology becomes essential for the educational goals of the classroom with the use of technology.	**Adaption** Integrates new technology into traditional classroom practice. Here they often focus on increased student productivity and engagement by using word processors, spreadsheets and graphics tools
Reorientation Is when teachers begin to rethink the educational goals of the class with the use of technology.	**Appropriation** Focus on cooperative, project-based and interdisciplinary work incorporating the technology as needed as one of the many tools
Revolution Is the evolving classroom that becomes completely integrated with technology in all subject areas. Technology becomes an invisible tool that is seamlessly woven into the teaching and learning process.	**Invention** Discover new uses for technology tools, for example, developing spreadsheet micros for teaching algebra or designing projects that combine multiple technologies.

Source: Rieber & Welliver (1989) and Report on 10 Years of ACOT Research (ACOT, 1995, p. 16)

Table 2: Stages of development in the use of ICT

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).

The System/School Models

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 a further publication leading from these has been released called: *Transforming learning through technology*. The 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' (Coughlin & Lemke, 1999, 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 (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. 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. 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 , Ravitz & Wong, 1999).

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 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. 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 the use of technology to support student learning. 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) 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.

Another system model, the Technology Maturity 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). To reinforce this approach they call the TMM a 'planning model'. 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). The Improvement Cycle of spiral development covers four phases, namely Organizational, Assessment, Formulation and Implementation Phases. 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 are the Emergent Stage; the Islands Stage; the Integrated Stage; and the Exemplary Stage.

These stages are measured in multiple areas, using different indicators tailored to each area. 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 by Compaq computers across the US. Although sophisticated as a tool, its technological rather than learning focus could be counted against it. But its completeness in approach is in its favour.

The Population Model

Nearly 100 years ago 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 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.

A well-known part of Rogers (1983) work addressed five types of adopters, namely innovators (described as venturesome); early adopters (respectable); early majority (deliberate); late majority (sceptical); and laggards (traditional). 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 the DoI model 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 take the innovation 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 is 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. 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 1960s), and hence less relevant, for example, in African or Asian countries, and its utility may diminish as time goes on.

Conclusions from the models

No one model is going to describe perfectly the circumstances for any particular teacher so there is no point in choosing or disregarding these models (all listed in Table 1) based on a single classification alone. Nevertheless classifying these models can draw attention to critical facets of each model and will allow more considered selections to be made about their relevance and use. The population model like Roger's DoI approach is useful for large groups but not for individuals. The systems-based models like the TMM model and the Instructional Transformation model take an individualistic approach but place a technological cast upon the task, as does the ACOT hierarchy. The CBAM and even the Typology of ICT Uptake model could be described as examples of models focusing largely on the individual rather than any ICT component. Many of the models have scales of development, and so the Learning Micro Models (CBAM, TIU and SoC) are the three models that seem, after this review, to have the better orientation towards learning and therefore may have a more 'appropriate' orientation for teacher development and school change with ICT.

The process to develop the framework

From the literature review of the models the authors and a group of education experts (teachers and systems people) met and gave critical feedback on the proposed framework developed from this process. The framework was then trialled and adjusted based on the feedback gained.

The framework developed focuses on teachers but sits within a context of schools and school systems. In terms of the use of ICT this context could be described in terms of a range of dimensions that would include a ***Teacher Professional ICT Attributes*** dimension. It is this dimension that is mainly addressed here. This ***Teacher Professional ICT Attributes*** dimension may be described by one outcome that may be taken from a set of teacher professional attributes outcomes. The framework is structured around this single ***Teacher Professional ICT Attributes*** outcome using the following set of concepts as illustrated below:

- layers to describe the outcome in increasing detail;
- stages of progression in the demonstration of this outcome;
- instruments to collect data on the demonstration of, and progress within, this outcome; and
- processes within which to apply the instruments and address the connection between the framework and context.

Outcome	The teacher exploits the characteristics of ICT to support the learning of students by, effectively integrating the use of ICT, wherever appropriate, into constructivist learning environments, and contributing to relevant learning communities.
Layers	This outcome is described in three layers. 1 Overall outcome. 2 Components – Vision & Contribution, Integration & Use, Capabilities & Feelings. 3 Elements – each component has a number of elements.
Stages	Progression in the outcome is described in five stages: Inaction, Investigation, Application, Integration, and Transformation.
Instruments	There is an instrument for each layer and connected with the levels of demonstration. Each instrument may have a number of forms depending on the purpose of its use. Layer 1 Type of Response Layer 2 Typology of ICT Uptake Layer 3 Stages of Dialogue
Processes	There are sets of processes associated with the use of the instruments and addressing the context of the framework. The sets most directly connected to the ***Teacher Professional ICT Attributes*** dimension are the 'School Planning for ICT to support learning and teaching' and the 'Supporting Teacher's Decision-Making' sequences.

Table 3: Teacher professional ICT attributes outcome applying concepts

The ICT framework

There are three instruments, one developed for each layer. The outcome is described for each of the layers while progression in the outcome is described in stages. First, here are the three major layers (see Table 4).

	Description and Components
LAYER ONE **Overall Outcome**	The teacher exploits the characteristics of ICT to support the learning of students by, effectively integrating the use of ICT wherever appropriate into constructivist learning environments, and contributing to relevant learning communities. **Note:** It is envisaged that this would be one outcome taken from a set of outcomes for General Teacher Attributes.
LAYER TWO **Components of Outcome**	**Vision & Contribution** [V & C] **Integration & Use** [I & U] **Capabilities & Feelings** [C & F]
LAYER THREE **Elements of Components**	Each element describes more specifically aspects of a component of the outcome as it may relate to the teacher and his/her skills, work practices and beliefs. [V & C] – Purpose, Focus, Rationale, View of ICT, Contribution to Communities [I & U] – Frequency of Use, Implementation Strategies, Type of Activities & Pedagogy, Tasks for Applications, Assessing, Relevance, Connection with Curriculum Framework Outcomes. [C & F] – Potential, Roles, Source of Direction, ICT Skills, Affective Response, Concerns.

Table 4: The three major layers of the model that form the ICT instruments developed

In Layer One, progression is described in the five stages just in terms of the overall outcome with no reference to the detail of components or elements (see Table 5).

	Description of Key Difference(s)
Inaction	At this stage there is a general lack of action and/or interest.
Investigation	At this stage the teacher has developed an interest in using ICT with students and is beginning to act on this interest.
Application	At this stage the teacher is regularly using ICT with students and knows how to do so competently and confidently.
	Critical Use Border
Integration	At this stage the use of ICT becomes critical to the support of the learning environment and the opportunity for students to achieve learning outcomes through the learning experiences provided.
Transformation	At this stage the teacher is able to take on leadership roles (formal or informal) in the use of ICT and be knowledgably reflective on its integration by themselves and others.

Table 5: The stages of teacher development as an overall outcome

The literature review indicated that Layer One in Table 4 is reminiscent of many of the early attempts at indicating the stages of teacher development in relatively simplistic form. In Layer Two, progression is described for each component but only for four of the five stages, as it was evident that the Inaction stage needed no further description. For example, progression for the Vision & Contribution component of the outcome is described as the following four stages of where a teacher might be as investigation; application; integration and transformation as further elaborated in Table 6.

Investigation	▪ Regards ICT as an object and rather incomprehensible. Accepts that it has some uses but has reservations. ▪ Considers student ICT literacy needs. ▪ Little contribution to school ICT planning. ▪ Largely unaware of how or whether their teaching will change.
Application	▪ Treats ICT as an instrument. Agrees they have a place in teaching and learning. ▪ Considers student productivity and engagement in use of ICT.

	▪ Some contribution to school planning mainly to request items. ▪ Has undifferentiated and even confused but changing views on their changing teaching role.
Integration	▪ Uses ICT as a tool to address multiple learning outcomes. ▪ Considers opportunities for students to use ICT to demonstrate learning outcomes. ▪ Consistently contributes to school communities and planning both in terms of engagement and policy. ▪ Expects their learning approaches to develop as ICT integration grows.
Transformation	▪ Envisages and uses ICT as catalyst to appropriately support all learners in a collaborative way. ▪ Considers the two-way relationship between learning and ICT use. ▪ Is a leading contributor to school communities and planning in the use of ICT. ▪ Envisages and can discuss multiple learning roles all of which are changed by ICT integration.

Table 6: The four stages of teacher development for Layer Two.

The instrument for the outcome at Layer Three, referred to as *Stages of Dialogue*, is based around interviews with teachers. For example, the section related to the Vision & Contribution component is illustrated in Table 7.

	Dialogue Questions	***Stage***	**Response**	**Steps to Progress**
Purpose	What are the main purposes you want to use ICT for with your students?			
Focus	What are you focusing on at the moment in the use of ICT?			
Rationale	What is the value in having your students use a computer?			
View of ICT	How does ICT fit into your teaching overall?			
Contribution to Communities	How do you contribute to school ICT planning? What would you like to contribute? What involvement do you have with learning communities that use ICT?			

Table 7: The *Stages of Dialogue* tool for the Layer Three outcome

Finally, the framework and three instruments need to be used within the context of sets of processes conducted by schools and/or systems. Broadly there are six sets of processes a school may take to support progress in the use of ICT:

- school planning for ICT to support learning and teaching;
- the development of student ICT literacy;
- the use of learning and information management systems;
- the development of school ICT policy and planning;
- the development of staff ICT capabilities;
- the development of policy and planning for system support and direction; and
- teacher's decision-making about using ICT.

For example, within the first set of processes, school planning for ICT to support learning and teaching, may include the following processes within which to utilise the framework and instruments.

1) Targets — School community determines targets. Any of the layers may be used depending on the level of investment available.

2) Teacher Maps — Each teacher maps his/her use of ICT to support learning with students. This may be in consultation with peers and/or

	leaders (e.g. coordinator). Uses a version of one of the instruments.
3) Compare	Compare teacher maps with the targets set in step 1.
4) Support	In collaboration with knowledgeable others (e.g. coordinator) determine what challenges are inhibiting each teacher's progress and what support they require to progress. Use a version of one of the instruments.
5) School Profile	Aggregate maps of all teachers in school to create a school profile.
6) School Resources	Aggregate challenges and support requirements and compare with school and system resources.
7) School Plan	Create a school plan for progress that will include the development of: curriculum, teachers, ICT infrastructure, ICT and other policy and practice.
8) Teacher Plans	Develop individual teacher plans for progress that may include professional development, professional support, ICT resource allocation, etc.

This holistic, structured approach to the development of teachers' professional ICT capability through a consideration of their attributes is arguably more likely to provide the structure that will lead to the changes in pedagogy and school reform that many have argued that the use of ICT should be coupled with. It takes account of the complexity for teachers in progressing their understanding and practice in integrating the use of ICT to support learning and the context within which this occurs. Further, it provides a structure for formative feedback where the aim is continuing progress rather than mere classification. While the framework is designed to support teacher professional development in the integration of ICT use the focus is through research. At the time of writing the original instruments were available in a PDF document at the URL http://www.eddept.wa.edu.au/cmis/eval/downloads/pd/framework.pdf These instruments were developed in consultation with a reference committee of teachers and departmental people and have been used to gather pertinent data in Western Australian schools. Since their initial development these instruments have been used and although they are being fine-tuned it is interesting to observe how little they have changed as they are proving to be stable and effective instruments.

Conclusion

This paper describes the process undertaken to develop a framework based on previous research to support, describe and promote good practice in the use of ICT in learning and teaching in schools in Western Australia. It was developed on the premise that teachers always aim to look for better ways of doing things and therefore their use of ICT should support this as using ICT does not make a teacher better. It has attempted to encapsulate the complexity of issues involved in teacher competencies in ICT usage and uptake. It considers teacher competence, the system environment and the ICT capacity of the setting in which they find themselves in this endeavour, and encourages a multifaceted approach to its investigation. The literature suggested the five dimensions that became the context of this framework; that is, *Students*, *Learning Environments*, *Teacher Professional ICT Attributes*, *ICT Capacity*, and *School & System Environment*. This framework has been developed with a strong theoretical framework behind it. The layers allow various levels of investment in the processes. Its complexity mirrors the real world, where it is multi-faceted and flexible enough to be used by individuals, groups, schools or educational organizations, and to accommodate the range of investments in time and energy that they might wish to devote. Furthermore, because of its breadth and multifaceted nature previous efforts can provide helpful staging points for subsequent investigations using the model in greater depth.

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