Framework

A Framework to Articulate the Impact of ICT on Learning in Schools

Developed by Dr. C. Paul Newhouse for the

Western Australian Department of Education.

December, 2002

This document provides a framework to articulate the areas of impact of ICT in schools and strategies for monitoring and evaluating each of the areas of impact at the school and system levels. The document is provided in both hard copy and electronic forms (PDF and DOC formats). It is recommended that such a framework be represented and provided as an online tool. As a minimum the Word document electronic file should be provided to district and school personnel to allow editing for local requirements.

Companion Document

This framework is based on a review of the literature concerned with the impacts of ICT on learning, curriculum, learning environments, students, teachers, schools and school systems.

The Impact of ICT on Learning and Teaching

by Paul Newhouse, December, 2002

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Overview

This framework suggests a number of dimensions to consider when evaluating the use of ICT to improve student learning. Three of these dimensions are explored in some detail with the statement of an outcome for schools to consider for each dimension (outcomes stated below). These outcomes are specifically addressed with the development of indicators, research questions and example data collection instruments.

Outcome for ICT Supporting Constructivist Learning Environments

ICT is used to support pedagogic practices that provide learning environments that are more Learner-centred, Knowledge-centred, Assessment-centred, and Community-centred.

Outcome for School ICT Capacity

Schools provide ICT capacity to ensure that all teachers and students have immediate access to all software that is required to support the curriculum and adequate support to implement its use.

Outcome for School Environment

That school environment is supportive of teachers and students use of ICT built on a shared, community-based vision that prepares students to learn, work and live successfully in a knowledge-based, global society.

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Dimensions of a Framework

The literature review unequivocally found that **it is not possible to provide a meaningful framework to describe or measure the direct impact of ICT on student learning** per se. Most educational researchers view media comparison studies as of little value, misleading, and not generalisable. Where such studies have been conducted it has not been possible to identify a purely ICT effect disentangled from other elements of the learning environment. Most educational researchers would view such disentangling as counterproductive. Further, it has become increasingly difficult to measure student learning as more is understood of the complexities of learning. However, this review has identified significant impacts of the use of ICT on students, learning environments, teachers and pedagogy, schools provision of ICT capacity, and school and system organization, policy and practice. These are presented here as five dimensions [possible components given in brackets].

Students [ICT Capability, Engagement, Achievement of Learning Outcomes]

Learning Environments Attributes [Learner-centred, Knowledge-centred, Assessment-centred, Community-centred]

Teacher Professional ICT Attributes [Vision & Contribution, Integration & Use, Capabilities & Feelings]

School ICT Capacity [Hardware, Connectivity, Software, Technical Support, Digital Resource Materials]

School Environment [Leadership & Planning, Curriculum Organisation, Curriculum Support, Community Connections, Accountability]

The relationships of these dimensions to each other are represented in the diagram in Figure 1.

Outcomes for the Dimensions

Each dimension may be represented by an outcome as described below.

Students	Through the use of ICT students develop an appropriate level of capability, become more engaged with their own learning, and achieve learning outcomes across the curriculum at a higher level.
Learning Environments Attributes	ICT is used to support pedagogical practices that provide learning environments that are more Learner-centred, Knowledge-centred, Assessment-centred, and Community-centred.
Teacher Professional ICT Attributes	The teacher exploits the characteristics of ICT to support the learning of students by, effectively integrating their use, wherever appropriate, into constructivist learning environments, and contributing to relevant learning communities.
School ICT Capacity	The school provides ICT capacity to ensure that all teachers and students have immediate access to all software that is required to support the curriculum and adequate support to implement its use.
School Environment	That school environment is supportive of teachers and students use of ICT built on a shared, community-based vision that prepares students to learn, work and live successfully in a knowledge-based, global society.

NOTE: In many situations the school would need to work in tandem with the school system (e.g. District Office or Head Office or Curriculum Council) to address these dimensions, particularly the School Environment and School ICT Capacity.

Impact of ICT in Schools

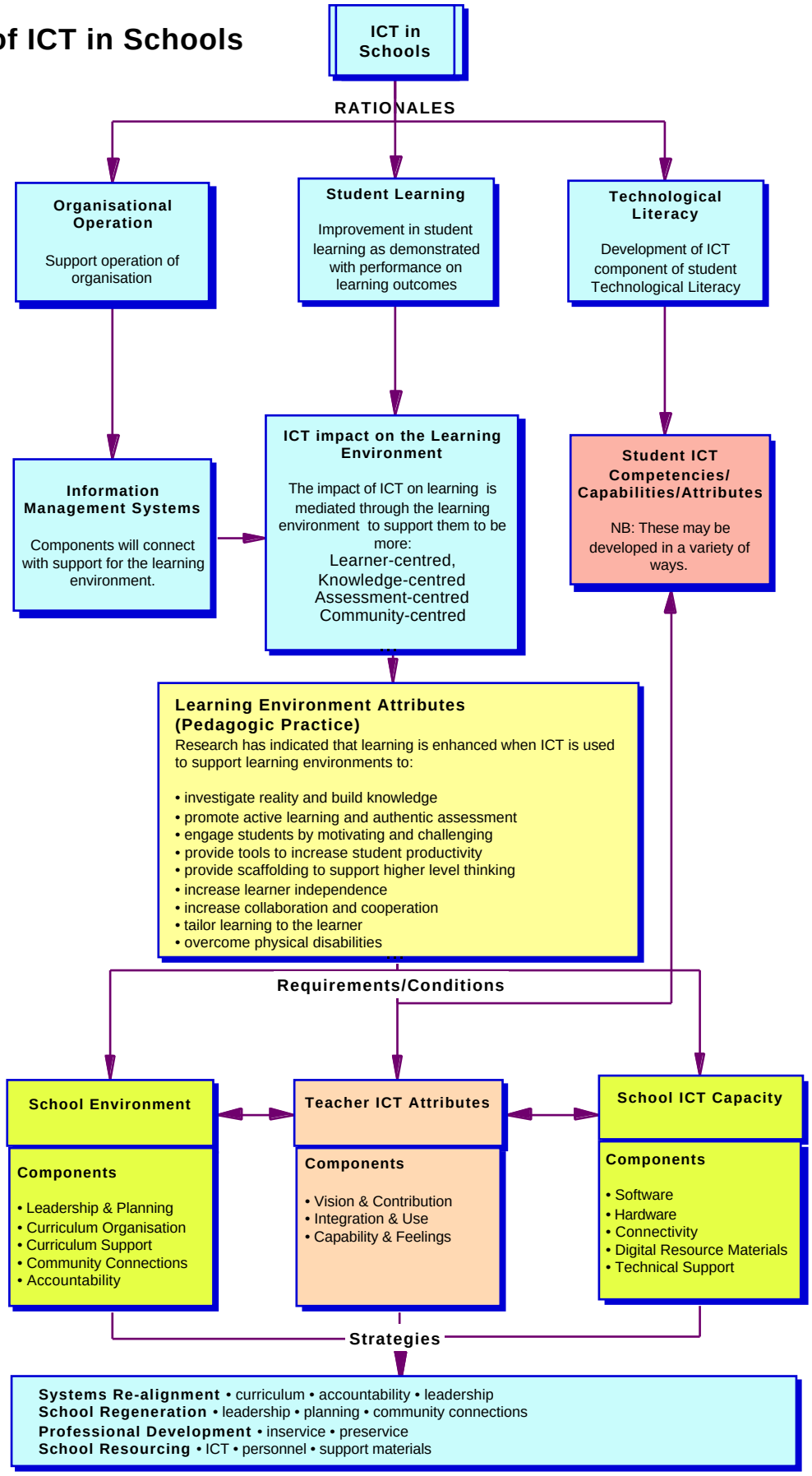

Figure 1: ***Schematic diagram representing the relationships between the dimensions of impact of ICT in schools.***

Students Dimension

[ICT Capability]

The ***Engagement*** and ***Achievement of Learning Outcomes*** components of the **Students** dimension should be subsumed within the **Learning Environments Attributes** dimension. This is because it is not possible to measure either in terms of the impact of ICT. Therefore, only the ***ICT Capability*** component is required. Such a framework is already being developed nationally in Australia and therefore need not be repeated here.

Learning Environments Attributes (Pedagogic Practices) Dimension

[Learner-centred, Knowledge-centred, Assessment-centred, Community-centred]

While it is not possible, strictly speaking, to develop a framework for judging the impact on learning environments it may be possible to describe the ways in which ICT could be, or was contributing to, the development of constructivist learning environments. This is developed here and is largely based on the work of the ***Committee on Developments in the Science of Learning*** and material from ***enGauge***, ***NETS***, and the ***Seven Dimensions for Gauging Progress***. It should be noted that ICT is only one component of the environment and should be an enabling component not a determining component of the environment.

Teacher Professional ICT Attributes Dimension

[Vision & Contribution, Integration & Use, Capabilities & Feelings]

This dimension is being developed in another project and therefore is not developed here.

School ICT Capacity Dimension

[Hardware, Connectivity, Software, Technical Support, Digital Resource Materials]

This dimension is developed here and built upon the existing "Framework for the Implementation of Learning Technologies in WA Government Schools". It is described in terms of the ideal situation with a set of indicators to this ideal that schools would use to identify major areas for concern and determine strategies.

School Environment Dimension

[Leadership & Planning, Curriculum Organisation, Curriculum Support, Community Connections, Accountability]

This dimension is developed here and is largely based on material from ***enGauge***, ***NETS***, and the ***Seven Dimensions for Gauging Progress***. It is described in terms of the ideal situation with a set of indicators to this ideal that schools and systems would use to identify major areas for concern and determine strategies.

Learning Environments Attributes (Pedagogic Practices)

The use of ICT to support various pedagogic practices has been found to have a positive impact on the learning environment and thus on student learning. The accompanying review of literature distilled these into nine types of practice in the use of ICT. A summary of some of the research supporting these practices is provided in the table below.

ICT Pedagogic Practice	Examples of Supporting Research
Investigate reality and build knowledge	In Canada research results point to the "transition from closed to open teaching and learning environments" (Laferrière, Breuleux, & Bracewell, 1999). Students using the CSILE application showed gains on measures of depth of understanding and reflection (Scardamalia & Bereiter, 1996). Students use ICT to analyse, organize and creatively represent real information in constructing knowledge (Bereiter, 1998).
Promote active learning and authentic assessment	An evaluation of IMMEX Teacher Institutes have shown statistically significant improvement in teacher preparation to: manage a class of students who are using hands-on/laboratory activities, use a variety of assessment strategies, use performance-based assessment (WestEd, 1998). Students using the CSILE application showed gains on measures of progressive thought and reflection (Scardamalia & Bereiter, 1996). ICT may be used to support students to design and produce their own knowledge representations and thereby engage with powerful learning experiences (Berge & Collins, 1998). The evaluation of learning outcomes requires methods that measure understanding. These can be supported by the use of ICT (Brown, 1994).
Engage students by motivation and challenge	Students have more positive attitudes towards their classes and learning when ICT use is included (Baker, Gearhart, & Herman, 1994; Kulik, 1994). The use of ICT has consistently improved students' attitudes towards learning and their own self-concept (Sivin-Kachala, 1998). Educational technology has had positive effects on student attitudes toward learning and on student self-concepts. Evidence of such is strongest in language arts, mathematics, science, and telecommunication/video technologies. (The Software Information Industry Association., 1999) Content-related graphics (both static and animated) and video can help improve student attitudes and motivation in mathematics and science. (The Software Information Industry Association., 1999)
Provide tools to increase student productivity	Students tend to complete more in less time when they use ICT (Kulik, 1994). Students using an integrated learning system to support the development of skills in spelling, vocabulary, reading and mathematics showed improvements more cost effective than other major initiatives (Mann, Shakeshaft, Becker, & Kottkamp, 1999).
Provide scaffolding to support higher level thinking	It appears that appropriate use of ICT results in new learning experiences requiring higher levels of thinking and problem-solving (Baker et al., 1994). Animation and video can enhance learning when the skills or concepts to be learned involve motion or action. (The Software Information Industry Association., 1999) Canadian students using portable computers created portfolios that demonstrated "advanced technology, inquiry, and meta-cognitive skills as well as deep understanding of a number of topics" (Laferrière et al., 1999). An evaluation of IMMEX Teacher Institutes have shown statistically significant improvement in teacher: knowledge and use of problem-solving strategies in the classroom and present applications of concepts. (WestEd, 1998)

	Students used simulation and cognitive support software the show improvement in higher order mathematical thinking (Wenglinsky, 1998).
Increase learner independence	Foreign language and ESL (English as a Second Language) students can benefit from presentation of video segments with captioning (i.e., subtitles in the target language) (The Software Information Industry Association., 1999). Students using the CSILE application showed significant improvement in independent thinking (Scardamalia & Bereiter, 1996).
Increase collaboration and cooperation	In courses using computer-based networks, many students who seldom participated in face-to-face class discussions became more active participants online. (The Software Information Industry Association., 1999) Introducing technology into the learning environment has been shown to make learning more student-centered, to encourage cooperative learning, and to stimulate increased teacher/student interaction. (The Software Information Industry Association., 1999) An evaluation of IMMEX Teacher Institutes have shown statistically significant improvement in teacher preparation to: use cooperative learning groups (WestEd, 1998) The use of ICT encourages teachers to use more cooperative work and less teacher lecturing (Baker et al., 1994).
Tailor learning to the learner	Addressing language impairment (Turner & Pearson, 1999) Students who are field-independent learners (i.e., learners who rely less on contextual clues in defining meaning) perform better than field-dependent learners when using hypertext. (The Software Information Industry Association., 1999) An evaluation of IMMEX Teacher Institutes have shown statistically significant improvement in teacher preparation to: teach groups that are heterogeneous in ability and take students' prior conceptions into account when planning curriculum and instruction. (WestEd, 1998)
Overcome physical disabilities.	There are many case studies where children with physical disabilities may use adaptive technologies to maximise their successful use of ICT (Donegan, 1999).

Aligning with Constructivist Learning Environments

These nine types of practices are aligned with providing a learning environment that is more Learner-centred, Knowledge-centred, Assessment-centred, and Community-centred. The table below demonstrates this alignment.

ICT Pedagogic Practice	Learner centred	Knowledge centred	Assessment centred	Community centred
Investigate reality and build knowledge	Construct personal meaning	Real-world, useful & deep knowledge	Authentic assessment	Use variety of information sources
Promote active learning and authentic assessment	Construct personal meaning		Authentic assessment	
Engage students by motivation and challenge	Learner characteristics	Engaged with content at a deeper level		
Provide tools to increase student productivity	Learner characteristics	Focus on broader and deeper knowledge.		
Provide scaffolding to support higher level thinking	Learner characteristics	Deep knowledge	Assess higher level thinking	
Increase learner independence	Learner characteristics		Self evaluation & reflection	Learning community
Increase collaboration and cooperation			Peer evaluation	Learning community
Tailor learning to the learner	Learner characteristics		Self evaluation & reflection	
Overcome physical disabilities.	Learner characteristics			

On the basis of these nine types of pedagogical practice the following outcome with indicators has been developed to describe the positive impact of ICT on learning environments that may have a positive impact on learning.

Outcome for ICT Supporting Constructivist Learning Environments

ICT is used to support pedagogic practices that provide learning environments that are more Learner-centred, Knowledge-centred, Assessment-centred, and Community-centred.

Nine indicators of demonstration of the ***ICT Supporting Constructivist Learning Environments*** outcome have been identified and are provided with descriptions, explanations, and illustrative examples in the table on the next three pages.

Indicators for ICT Supporting Learning Environments

Indicator ICT is used to …	Description	Explanation	Examples [These are illustrative, not prescriptive.]
Investigate reality and build knowledge	ICT allows students to investigate more thoroughly the real world using up-to-date information and tools to build a broader and deeper knowledge base.	Students can access various information sources using standalone databases, online systems, and data logging systems. They can then use ICT tools to analyse and interpret such information, receive expert feedback, refine their understanding, build new knowledge and transfer knowledge from school to non-school settings.	Students use word processors, spreadsheets and graphics tools to collect and analyse information, and develop a design for a new school. Students collect and analyse data using ICT probes to investigate water salinity problems in a local river.
Promote active learning and authentic assessment	ICT may be used to support students in being more active as participants in their own learning and learn by doing rather than just listening or reading. As a result this encourages assessment to result from their activity rather than being an isolated activity.	Students' engagement with the curriculum will increase as they are afforded opportunities to create their own information and represent their own ideas. Students can have more influence on the learning processes and the activities can be more responsive to their needs. This better facilitates the development of conceptual frameworks by students to assist in deeper levels of learning. Where assessment emanates from active learning it is termed authentic.	Students create a digital video of a school camp to communicate what they valued. Students use a simulated environment to consider building a town. Students interact with children from another country to create a play. Students use online forums for feedback and reflection to promote greater depth of explanations of concepts.
Engage students by motivation and challenge	The interactive, multimedia, and communication characteristics of ICT may be used to provide more motivating and challenging learning experiences that encourage students to be more engaged with their learning.	Software developers have increasingly used interactive, multimedia and communication characteristics of ICT to provide more stimulating features and a wide range of interesting learning experiences. Generally students like to use computers and are likely to develop more positive attitudes towards their learning and themselves when they use computers. This is likely to help to maintain student interest and interest a wider range of students. The interactive and multimedia features can be used to help students grapple with more challenging concepts and ideas and encounter similar concepts within a variety of contexts.	Students use a well structured phonics tutorial package that uses stimulating media and increasing challenge. Students solve increasingly challenging mathematics problems within a virtual world. Students write an autobiographical piece for an electronic pen-pal.

Provide tools to increase student productivity	ICT tools may be used to increase student productivity, particularly with repetitive, low-level tasks involving writing, drawing and computation. While it may be necessary for students to develop these skills at some time on most occasions they are pre-requisite to some higher-level task.	Unnecessary repetition of low-level tasks is inefficient, non-motivational and may obscure the real purpose of the learning activity. Many computer applications provide the tools to support students in quickly completing these lower-level tasks so that they can focus on the main purpose of the activity. Word processors, graphics packages, database packages, spreadsheets and other software support the performance of students. The use of scaffolds and tools can help students to solve problems that may have previously been considered to be too difficult for them. Such scaffolding tools are often referred to as Electronic Performance Support Software (EPSS).	Students construct multiple graphically representations of data collected from a survey. Students use a spreadsheet to calculate the costs associated with installing a reticulation system and use the results to successively improve their own designs.
Provide scaffolding to support higher level thinking	Software tools can be used to support the development of higher level thinking skills such as application, analysis and synthesis.	Tools can be used to analyse data, present data, link data or information, present information in different formats, simulate environments and conditions, and support interactive communications. This allows teachers to consider providing a range of activities to assist students to become critical thinkers, designers and problem solvers. Computer systems provide a wider range of motivating situations in which students can develop and apply these higher level thinking skills and provide opportunities to develop 'deep knowledge'.	Students use a table in a document to compare and contrast writing styles in two narratives. Students construct concept maps using graphic organiser software. Students use a word processor to edit a narrative from first to second person. Students use a software wizard to guide them in creating a budget.
Increase learner independence	ICT may be used to provide learning experiences when and where they are needed and allow students to progress at their own pace.	Interactive software and online systems may be used to provide students with greater independence not only in terms of when and where they learn but also what they learn. It is not necessary for all students to do the same thing at the same time. The class does not have to be treated as one group. Individuals or groups of students may consider learning topics independently of the teacher. This is often discussed in terms of lifelong learning, learner-driven learning or project-based learning. ICT tools can be used to create records of thoughts and support reflection and assessment of progress.	Students use an online system to support contract project work. Students independently use online typing tutor software. Students unable to attend a school use online tutorial and management systems.

Increase collaboration and cooperation	ICT may be used to support learning experiences that involve more cooperation among learners within and beyond school and a more interactive relationship between students and teachers. In so doing richer learning communities are developed.	Collaboration is a philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning and respect the abilities and contributions of their peers. Cooperation is a structure of interaction designed to facilitate the accomplishment of a specific end product or goal through people working together in groups. ICT provides good support for team-based project work. The use of ICT to support collaborative and cooperative learning is extrapolated to the support of learning communities.	Students work in teams on a Webquest project. Students use email to collaborate with the local police with regard to traffic hazards. Students contribute data on local weather conditions to the evening TV weather report.
Tailor learning to the learner	ICT may be used to support more individualised learning programmes through the use of intelligent tutoring systems and/or computer managed learning systems. Students can be provided with computer support for learning activities tailored to their individual needs, particularly in the case of students with special needs.	Traditionally it is not possible to provide each student with an instructor and/or specially design learning experiences. The programmable and interactive characteristics of computer systems may be used to develop software which simulates the role of an instructor. Intelligent tutoring software may use information about the student to recommend appropriate sequences or sections of a tutorial for the student. Each student may encounter different experiences when using the same piece of software. Feedback can be more timely and individual. Computer Managed Learning (CML) systems may be used to assist teachers in planning and monitoring more individualised learning programmes. The use of online technologies further expands the potential of intelligent tutoring and CML.	Students use an automated reading tutor that displays stories on a screen and listens to them read aloud. Students use an intelligent tutoring system to consider the structure of accounts for a large company. Teachers use a CML system to plan and monitor individual learning programmes.
Overcome physical disabilities.	The variety of input and output devices available provide the opportunity for students who are physically handicapped to be involved in similar learning activities as other students.	For some students computers provide the only environment which they can manipulate and the only tools that reduce their level of disability.	Students use modified keyboards and mouse-drivers to allow them to use regular software packages.

School ICT Capacity

This dimension is built upon the existing "Framework for the Implementation of Learning Technologies in WA Government Schools" (Education Department of Western Australia, 1998).

Outcome for School ICT Capacity

Schools provide ICT capacity to ensure that all teachers and students have immediate access to all software that is required to support the curriculum and adequate support to implement its use.

Components

Five components contributing to the outcome have been identified. The elaboration describes the ideal situation with the indicators designed to assist schools to identify major areas for concern and determine strategies.

Component	Elaboration	Indicators
Software	A wide range of applications is available to students and teachers where the applications are designed to match user characteristics and the requirements of curriculum tasks.	School has licenses for students and teachers to access a range of appropriate software as required. Students and teachers able to readily access this software when required.
Hardware	Students and teachers have access to computer processing adequate to use required software applications and digital resource materials. Students and teachers have access to peripheral devices suited to user characteristics and the requirements of curriculum tasks.	Extensive variety of peripheral technologies for different curriculum needs in all learning areas. Students have unlimited access to select and use learning technologies. A planned and dynamic hardware repair and replacement program is in place. Effective policies and procedures for the management of hardware resources are evident.
Connectivity	Students and teachers have access to networking, including to the internet, that provides high quality access to online services.	Extensive range of online services available throughout the school (e.g. email, access from home, shared curriculum resources, intranet, video-conferencing facilities). A school wide network that includes curriculum and administration with excellent Internet access.
Technical Support	Technical support and maintenance is available to teachers and students when and where required.	Technical support and maintenance is well managed by skilled experts from a technical support contract or school appointed technician. Students and teachers are not stopped from using a learning technology due to technical failure.
Digital Resource Materials	Teachers and students readily select and access digital resource materials appropriate to their needs.	Planned approach to management and use of digital resource materials. Selection of digital resource materials is coordinated throughout the school and strongly linked to the curriculum needs of students and staff for all learning areas. There is management and coordination of all digital resource materials across all learning areas.

School Environment

This is based on material from ***enGauge (North Central Regional Educational Laboratory, 2002)***, ***NETS (International Society for Technology in Education, 2000)***, and the ***Seven Dimensions for Gauging Progress (Lemke & Coughlin, 1998)***. It is described in terms of the ideal situation with a set of indicators that schools would then use to identify areas for concern and strategies.

Outcome for School Environment

That school environment is supportive of teachers and students use of ICT built on a shared, community-based vision that prepares students to learn, work and live successfully in a knowledge-based, global society.

Components

Five components contributing to the outcome have been identified. The elaboration describes the ideal situation with the indicators designed to assist schools to identify major areas for concern and determine strategies.

Component	Elaboration	Indicators
Leadership & Planning	The school provides leadership and planning structures based on clear goals that encourage and support teachers and students in their use of ICT.	The school has a comprehensive long-term plan for the use of ICT in schools.
Curriculum Organisation	The intended curriculum is organised in a manner that is conducive to the use of ICT to support learning and teaching processes.	The curriculum encourages student work that addresses issues that have meaning, reaching out beyond the classroom to real-world practice. Assessment processes do not preclude the use of ICT.
Curriculum Support	Teachers are provided with adequate support to select appropriate applications of ICT to address the requirements of the intended curriculum.	There are curriculum support personnel, readily available to teachers, with expert experience in the integration of ICT in learning and teaching processes. Teachers have access to a range of curriculum support materials targeted at the use of ICT to support learning for the type of students they teach and the areas of the curriculum they engage with.
Community Connections	The school recognises local and global communities as critical partners and stakeholders in the learning and teaching process.	There is a statement of vision that identifies and builds upon the potential mutual benefits from community linkages for learners and the community. Formal technology-related structures and processes engage parents, community members, school staff, and learners in meaningful exchanges, interactions, and partnerships that advance the use of ICT in schools.
Accountability	The school has adequate systems to ensure accountability in the use of ICT.	The school has established the metrics and benchmarks for effective use of ICT at the student, teacher, and systems levels. The school collects and analyses data to track progress in the use of ICT and correlate findings. Decision making at all levels about ICT is informed and influenced by the results of the analysis of data to track progress.

NOTE: In many situations the school would need to work in tandem with the school system (e.g. District Office or Head Office or Curriculum Council) to address these components.

Measuring the Impact of ICT on Learning Environments

This section provides research questions, methodology and sample data collection instruments designed to address the Learning Environments Attributes (Pedagogic Practice) dimension of the framework. The outcome for this dimension is:

> ICT is used to support pedagogic practices that provide learning environments that are more Learner-centred, Knowledge-centred, Assessment-centred, and Community-centred.

For each of the nine indicators of the outcome research questions are suggested that could be used by systems or schools to assess the impact of ICT on learning environments in a school. A methodology for assessing this impact is suggested through the collection of sets of data. These data are qualitative in nature based on interviews, observations and document reviews and therefore expert interpretation of these data would be necessary.

Research Questions and Methodology

It is suggested that a school, group of teachers or individual teacher starts by considering just one or two of the indicators of the outcome. Data should be collected and analysed over a period of time (minimum of one term). As confidence, experience and competence develops the other indicators may be added and therefore a larger quantity of data collected.

As a first step the indicators and research questions could be used to discuss the ideas and develop a common understanding at the school level. Teachers and/or groups of teachers could be guided through reflective episodes to suggest the current impact of ICT and recommend future action to increase that impact.

The following two pages present the indicators, research questions and methods for measuring the positive impact of the use of ICT on learning environments.

Research Questions and Methods to Measure the Impact of ICT on Learning Environments

Schools need to collect data to consider the following research questions in relation to all their students and their learning environments.

Indicator	Research Questions	Methods of Measuring Impact
Investigate reality and build knowledge	In what ways, to what degree and how often have students investigated the real world using up-to-date information? How have students used tools to build a broader and deeper knowledge base? How has ICT been used, and how often, to investigate the real world and build knowledge?	Questionnaires and interviews of students and teachers. Work samples of a random sample of students. Student logs of activity. Review of learning programmes.
Promote active learning and authentic assessment	In what ways, to what degree and how often have students been active as participants in their own learning and learn by doing rather than just listening or reading? To what extent does assessment emerge from student activity compared with being an isolated activity? How has ICT been used, and how often, to encourage students to be active as participants in their own learning and learn by doing?	Questionnaires and interviews of students and teachers. Review of learning programmes. Observation of lessons. Student logs of activity.
Engage students by motivation and challenge	What level of engagement do students have with their own learning? How has ICT been used, and how often, to provide more motivating and challenging learning experiences that encourage students to be more engaged with their learning?	Questionnaires and interviews of students and teachers. Observation of lessons.
Provide tools to increase student productivity	What proportion of student time is spent on completing repetitive, low-level tasks involving writing, drawing and computation that are not the main focus of study? How has ICT been used, and how often, to increase student productivity, particularly with repetitive, low-level tasks involving writing, drawing and computation?	Questionnaires and interviews of students and teachers. Work samples of a random sample of students. Student logs of activity. Review of learning programmes. Observation of lessons.

Provide scaffolding to support higher level thinking	What proportion of student time is spent on higher level thinking tasks such as application, analysis and synthesis? How has ICT been used, and how often, to support the development of higher level thinking skills such as application, analysis and synthesis?	Questionnaires and interviews of students and teachers. Work samples of a random sample of students. Student logs of activity. (Apply Bloom's taxonomy.)
Increase learner independence	In what ways, to what degree and how often have students been encouraged to demonstrate independent learning and progress at their own pace? How has ICT been used, and how often, to provide learning experiences when and where they are needed?	Questionnaires and interviews of students and teachers. Student logs of activity. Review of learning programmes.
Increase collaboration and cooperation	In what ways, to what degree and how often have students been involved in learning experiences involving cooperation and/or collaboration among learners within and beyond school? What is the learning relationship between the teacher and students? How has ICT been used, and how often, to support learning experiences that involve cooperation among learners within and beyond school and a more interactive relationship between students and teachers?	Questionnaires and interviews of students and teachers. Student logs of activity. Review of learning programmes. Observation of lessons.
Tailor learning to the learner	In what ways, to what degree and how often have students been provided with learning experiences based upon their personal learning characteristics and needs? How has ICT been used, and how often, to support more individualised learning programmes tailored to their individual needs, particularly in the case of students with special needs.	Questionnaires and interviews of students and teachers. Review of learning programmes.
Overcome physical disabilities.	In what ways, to what degree and how often have students with physically handicaps used ICT input and/or output devices to be involved in similar learning activities as other students?	Questionnaires and interviews of students and teachers. Student logs of activity. Observation of lessons.

Research Questions

Investigate reality and build knowledge

In what ways, to what degree and how often have students investigated the real world using up-to-date information?

How have students used tools to build a broader and deeper knowledge base?

How has ICT been used, and how often, to investigate the real world and build knowledge?

Promote active learning and authentic assessment

In what ways, to what degree and how often have students been active as participants in their own learning and learn by doing rather than just listening or reading?

To what extent does assessment emerge from student activity compared with being an isolated activity?

How has ICT been used, and how often, to encourage students to be active as participants in their own learning and learn by doing?

Engage students by motivation and challenge

What level of engagement do students have with their own learning?

How has ICT been used, and how often, to provide more motivating and challenging learning experiences that encourage students to be more engaged with their learning?

Provide tools to increase student productivity

What proportion of student time is spent on completing repetitive, low-level tasks involving writing, drawing and computation that are not the main focus of study?

How has ICT been used, and how often, to increase student productivity, particularly with repetitive, low-level tasks involving writing, drawing and computation?

Provide scaffolding to support higher level thinking

What proportion of student time is spent on higher level thinking tasks such as application, analysis and synthesis?

How has ICT been used, and how often, to support the development of higher level thinking skills such as application, analysis and synthesis?

Increase learner independence

In what ways, to what degree and how often have students been encouraged to demonstrate independent learning and progress at their own pace?

How has ICT been used, and how often, to provide learning experiences when and where they are needed?

Increase collaboration and cooperation

In what ways, to what degree and how often have students been involved in learning experiences involving cooperation and/or collaboration among learners within and beyond school?

What is the learning relationship between the teacher and students?

How has ICT been used, and how often, to support learning experiences that involve cooperation among learners within and beyond school and a more interactive relationship between students and teachers?

Tailor learning to the learner

In what ways, to what degree and how often have students been provided with learning experiences based upon their personal learning characteristics and needs?

How has ICT been used, and how often, to support more individualised learning programmes tailored to their individual needs, particularly in the case of students with special needs?

Overcome physical disabilities.

In what ways, to what degree and how often have students with physically handicaps used ICT input and/or output devices to be included in learning activities with other students?

Instruments to Collect Data to Address these Research Questions

This section provides sample questions that could be used to collect data. The quantity and type of data collected would depend on the level of investment that was available.

Questionnaires and interviews for teachers

Questions could involve the following …

Relevant Personal Characteristics

Number of Years Teaching

Number of Years Teaching with ICT

Current teaching situation (e.g. Primary year level taught or Secondary subject area)

Enjoyment of teaching

Qualifications and training associated with using ICT

Do you regard yourself as computer literate?

Aims for Learning Environments

Do you prefer directing most student work?

Do you encourage students to help each other?

What are your main aims in implementing your curriculum with your students?

What problems have you encountered fulfilling these aims?

What have you done to overcome these problems?

Pedagogic Beliefs

Do you think students can take responsibility for their learning?

Describe your main role(s) in your classes.

By students engaging in a set of learning activities that use a computer, this is likely to …

[SA=strongly agree, A=agree, D=disagree, SD=strongly disagree]

Lead to better (deeper) understanding of curriculum content.

Help students think in different and more interesting ways.

Be a faster way of learning.

Lead to students helping each other.

Lead to a better use of the teacher's time.

Lead to students completing more work.

Motivate students to enjoy learning.

Attributes of Current Learning Environments and Use of ICT

Sample Questions for Teachers
In what ways have students investigated the real world? What proportion of learning time is spent on these activities? What main sources of information do students access and how often (relatively) for each? In what ways have students been encouraged to build broader and deeper knowledge bases? How and how often has ICT been used to … • investigate the real world? • access up-to-date information? • build a broader and deeper knowledge base?
In what ways have students been active as participants in their own learning and learn by doing rather than just listening or reading? How often does this occur? To what extent does assessment emerge from student activity compared with being an isolated activity? What methods of assessment do you predominantly use (relative proportions)? How do you assess student understanding of concepts? How do you assess student attitudes towards learning? How has ICT been used to encourage students to be active as participants in their own learning and learn by doing? How has the use of ICT supported authentic assessment? How often has ICT been used for these purposes?
What proportion of students are very interested and engaged with their learning? What proportion of students are NOT very interested and engaged with their learning? How has ICT been used to provide more motivating and challenging learning experiences that encourage students to be more engaged with their learning? How often has ICT been used for this purpose?
Are you pleased with the standard of presentation of the work produced by your students? What proportion of student time is spent on completing repetitive, low-level tasks involving writing, drawing and computation that are not the main focus of study? How has ICT been used to increase student productivity, particularly with repetitive, low-level tasks involving writing, drawing and computation? How often has ICT been used for this purpose?
What activities have students engaged with that were designed to apply higher level thinking skillls such as application, analysis and synthesis? What proportion of student time is spent on these activities? How has ICT been used to support the development of higher level thinking skills such as application, analysis and synthesis? How often has ICT been used for this purpose?
In what ways have students been encouraged to demonstrate independent learning? How often have students been permitted to progress at their own pace? How has ICT been used to provide learning experiences when and where they are needed? How often has ICT been used for this purpose?

In what ways have students been involved in learning experiences involving cooperation and/or collaboration? What proportion of learning time is involved in these activities? How has this involved learners within the school and/or beyond the school? How often do your students work in groups? What is the predominant learning relationship between the teacher and students? How has ICT been used to support learning experiences that involve cooperation among learners within and beyond school and a more interactive relationship between students and teachers? How often has ICT been used for this purpose?
In what ways have students been provided with learning experiences based upon their personal learning characteristics and needs? How often have students been provided with these types of learning experiences? How has ICT been used to support more individualised learning programmes tailored to their individual needs? How often has ICT been used for this purpose?
How have you used adaptive input and/or output devices with students to overcome physical disabilities? Which devices and how often? In what situations have students with physical disabilities not been able to complete the same tasks on computers as other students?

For each teaching/learning strategy on the list below estimate the percentage of time your class experiences the strategy. Students work...

(a) from textbook.

(b) from teacher prepared materials.

(c) on individual projects.

(d) on group projects.

(e) with teacher in class discussion or investigation.

(f) instruction or demonstration by teacher.

(g) in some other way not listed above. [Describe: ……]

How often do you use computers with your classes?

Never **Once a Month** **Once a Week** **Most Times**

List the main uses of ICT you have facilitated with your students.

What outcomes do you address in using ICT?

Estimate the percentage of time your class uses ICT for the following purposes. Computers are used to …

(a) show a concept ... (b) make a product ... (c) provide a problem ... (d) store information ...

Do you think computers can be used to promote students' learning in your subject area?

YES **NO** **NOT SURE** Why? Please explain briefly.

Questionnaires and interviews for students

These would need to be rewritten in language appropriate for the developmental level of the students.

Sample Questions for Students
In what ways have you investigated the real world? What proportion of learning time is spent on these activities? What main sources of information do you access and how often (relatively) for each? In what ways have you been encouraged to build broader and deeper knowledge bases? How and how often has ICT been used to … • investigate the real world? • access up-to-date information? • build a broader and deeper knowledge base?
In what ways have you been active as a participant in your own learning and learn by doing rather than just listening or reading? How often does this occur? To what extent does assessment emerge from activity compared with being an isolated activity? What methods of assessment have you predominantly had (relative proportions)? How has ICT been used to encourage you to be active as participants in your own learning and learn by doing? How has the use of ICT been used in assessing your work? How often has ICT been used for these purposes?
How interested and engaged are your with your own learning? How has ICT been used to provide more motivating and challenging learning experiences that encourage you to be more engaged with your learning? How often has ICT been used for this purpose?
Are you pleased with the standard of presentation of the work you produce? What proportion of your time is spent on completing repetitive, low-level tasks involving writing, drawing and computation that are not the main focus of study? How has ICT been used to increase your productivity, particularly with repetitive, low-level tasks involving writing, drawing and computation? How often has ICT been used for this purpose?
What activities have you engaged with that were designed to apply higher level thinking skillls such as application, analysis and synthesis? What proportion of your time is spent on these activities? How has ICT been used to support the development of higher level thinking skills such as application, analysis and synthesis? How often has ICT been used for this purpose?
In what ways have you been encouraged to demonstrate independent learning? How often have you been permitted to progress at your own pace? How has ICT been used to provide learning experiences for you when and where they are needed? How often has ICT been used for this purpose?

In what ways have you been involved in learning experiences involving cooperation and/or collaboration? What proportion of learning time is involved in these activities? How has this involved learners within the school and/or beyond the school? How often do you work in groups? What is the predominant learning relationship between you and the teacher? How has ICT been used to support learning experiences that involve cooperation among learners within and beyond school and a more interactive relationship between students and teachers? How often has ICT been used for this purpose?
In what ways have you been provided with learning experiences based upon your own personal learning characteristics and needs? How often have you been provided with these types of learning experiences? How has ICT been used to support more individualised learning programmes tailored to your own individual needs? How often has ICT been used for this purpose?
How have you used adaptive input and/or output devices to overcome physical disabilities? Which devices and how often? In what situations have you not been able to complete the same tasks on computers as other students because of a physical disability?

For each teaching/learning strategy on the list below estimate the percentage of time your class experiences the strategy. You work...

(a) from textbook.

(b) from teacher prepared materials.

(c) on individual projects.

(d) on group projects.

(g) with teacher in class discussion or investigation.

(h) instruction or demonstration by teacher.

(g) in some other way not listed above. [Describe: ……..]

How often do you use computers with your class work?

Never Once a Month Once a Week Most Times

List the main uses of ICT you have used for class work.

Work samples of a random sample of students

View a variety of student work and judge using the following criteria:

Relevance and reality of contexts and opportunity to build own knowledge

Productivity level of students particularly with respect to low-level tasks

Development of conceptual knowledge drawing on high level thinking skills

Student logs of activity

Students keep log entries associated with:

Relevance and reality of contexts and opportunity to build own knowledge

Active and reflective processes supported and connected to assessment processes

Productivity level of students particularly with respect to low-level tasks

Development of conceptual knowledge drawing on high level thinking skills

Degree of learner independence accommodated

Support for collaboration and group-work

Review of learning programmes: Document Review

Judge using the following criteria …

Relevance and reality of contexts and opportunity to build own knowledge

Active and reflective processes supported and connected to assessment processes

Productivity level of students particularly with respect to low-level tasks

Degree of learner independence accommodated

Support for collaboration and group-work

Accommodation for differences between learners

Observation of Lessons

Judge a sample of lessons using the following criteria …

Active and reflective processes supported and connected to assessment processes

Level of engagement of all students

Productivity level of students particularly with respect to low-level tasks

Support for collaboration and group-work

Definitions of common terminology

The following terminology has been used throughout this document.

Collaboration	A philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning and respect the abilities and contributions of their peers.
Computer	Electronic machine, operated under the control of instructions stored in its own memory, that can accept data (input), manipulate data according to specified rules (process), produce results (output) and store the results for future use.
Computer Literacy	Concerning the knowledge, skills and attitudes which enable a person to use computer technology to benefit themselves and others related to tasks they wish to accomplish.
Computer Awareness	Concerning the understanding of the role of computer technology in society and the social implications associated with the use of computers in society.
Constructivism	The view of learning that requires the learner to actively construct conceptual meaning from experiences. This view is predominant among educational theorist in the world.
Cooperation	A structure of interaction designed to facilitate the accomplishment of a specific end product or goal through people working together in groups.
Curriculum	The word curriculum comes from Latin meaning to run a race-course. Its meaning in education has come to mean a combination of the learning outcomes, pedagogy, and content that students are to address. The Pennsylvania State Board of Education defines it as: ***A series of planned instruction that is coordinated and articulated in a manner designed to result in the achievement by students of specific knowledge and skills and the application of this knowledge.***
Curriculum Framework	Documents that describe curriculum goals and objectives for learning, and include direction for specific content areas, benchmarks, activities, and forms of evaluation.
Educational Technology	A term used throughout the world to refer to the use of any technologies to support the processes of learning and teaching.
E-mail	(Electronic mail) Text messages and computer files exchanged through computer communication, via Internet or intranet networks.
ICT	(Information & Communications Technology) Typically used to refer to computer technologies but strictly speaking should also include other technologies used for the collection, storage, manipulation and communication of information.

Internet	The international network of networks of computers using common protocols such as TCP/IP.
Intranet	A communications network, based on the same technologies used for the Internet but only available to authorised users within an organisation or company.
Learning Environment	The psycho-social and physical environments within which learning occurs. This may be physically contained within a classroom or may involve a complex of various locations, persons and materials.
Learning Outcome	That which students may demonstrate from what they have learned. In the Curriculum Framework these are described as sets of outcomes associated with areas of learning.
Learning Technologies	A term used principally in Australia to denote the use of technologies to support the processes of learning and teaching. Usually used to discuss the use of computer technologies in this capacity. Similar use to the internationally used term, educational technology.
Overarching Outcome	There are 12 overarching outcomes at the beginning of the Curriculum Framework that aim to direct the focus of all learning in Western Australian schools.
Pedagogy	A strict dictionary definition would state that pedagogy concerns the science of teaching children. It concerns what teachers do when they interact with children to support their learning. Most educators would consider that pedagogy encompasses the beliefs and actions of teachers including their teaching strategies, the organization of learning experiences and of the learning environment generally.
Technology Education	Learning and teaching associated with technologies where the technologies are the focus of study.
TCP/IP	(Transmission Control Protocol/ Internet Protocol) The communications protocol used to define the 'rules' for the transmission of data between computers and networks wishing to be part of the internet.
URL	(Universal Resource Locator) The unique address of any document available for access over the Internet.

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