
MONITORING PROGRESS TOWARDS THE NATIONAL
GOALS FOR SCHOOLING:
INFORMATION AND COMMUNICATION TECHNOLOGY
(ICT) SKILLS AND KNOWLEDGE

Report to the National Education Performance Monitoring Taskforce of the
Ministerial Council on Education, Employment, Training and Youth Affairs

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MONITORING INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) SKILLS AND KNOWLEDGE

EXECUTIVE SUMMARY

Purpose

The National Education Performance Monitoring Taskforce (NEPMT) was established in 1999 by the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA). One of the tasks set for the taskforce was to develop advice on the monitoring of student information and communications (ICT) skills and knowledge for the purposes of national reporting and monitoring progress towards the attainment of the National Goals for Schooling in the 21st Century.

This report:

- ◆ describes the context of learning ICT skills and knowledge as an outcome of schooling;
- ◆ identifies and describes performance measurement approaches, definitions and sources of data currently used in relation to schooling, research and national and international reporting on ICT skills and knowledge;
- ◆ evaluates the ICT measures currently in use in the context of the Goals for Schooling in the 21st Century;
- ◆ develops a strategy for monitoring the profile of ICT skills and knowledge of the school population, including: the most appropriate types of performance to be assessed, the comparisons to be made, the target populations, and the sampling approach to be employed;
- ◆ identifies further work required to establish an operational monitoring program; and
- ◆ incorporates views and assessments of the costs and benefits to school systems of introducing a national monitoring program.

Context of ICT in Schooling

- ◆ The context in which a program of monitoring of ICT skills and knowledge would operate is world in which the confluence of information technology, communications and knowledge will be one of the major influences on the future social and economic prosperity of the nation.
- ◆ The ICT skills and knowledge envisaged as necessary in a knowledge-based society are not simply the functional skills required to 'operate' computer technology, information and communications systems, but deeper knowledge structures and models that provide the basis for

interpreting and accessing the social and economic opportunities of such a society.

- ◆ The equitable distribution of ICT skills and knowledge across all sections of society will be an important aspect of ensuring access to social and economic opportunities for all sub-groups in the population.

Relevant Research

- ◆ Effective ICT learning environments in schools impact on a range of cognitive and non-cognitive outcomes for students.
- ◆ ICT has been shown to impact on cognitive learning outcomes, including:
 - curriculum specific knowledge;
 - ICT skills and knowledge; and
 - higher-order thinking and meta-cognitive skills.
- ◆ Research has also shown that effective ICT-based learning environments can have an impact on a range of non-cognitive learning outcomes, including:
 - work-place competencies, such as the capacity to work in teams;
 - social behaviours, such as cooperation and social acceptance of others; and
 - affective development, such as self-esteem, motivation and a sense of purpose.
- ◆ There is evidence that schools develop their ICT environments through a series of stages in the use of ICT:
 - initially seeking to teach students about ICT, but
 - subsequently seeking to integrate it across the curriculum as a means of providing learning environments that allow students to learn with ICT; and
 - full integration is achieved when learning takes place through ICT. In this final stage, ICT may potentially be part of a process for transforming learning through the reshaping of teachers' and students' knowledge of the processes of thinking and learning.
- ◆ The acquisition of ICT skills and knowledge takes place both inside schools and outside schools.
- ◆ Self-report survey data indicates that a high proportion of young persons believe they have acquired a wide range of 'basic' and a number of more 'advanced' ICT skills before they leave school.
- ◆ Survey data indicate significant disparities in the acquisition of ICT skills among sub-groups of young persons, with lower levels of skills being evident for indigenous students, girls and those living in smaller and rural communities.

Current & Planned Practices in Australian School Systems

- ◆ Current practices and plans across school systems clearly recognise both the broad based ICT skills and knowledge that all students need to acquire and more specialist skills and knowledge that students planning ICT specific post-school vocational pathways need to acquire.
- ◆ VET in schools programs and in post-school contexts provides certification at a number of levels in specific areas of ICT vocational skills and knowledge.
- ◆ There is no clear evidence that students following non-ICT pathways in post-school VET programs are systematically acquiring ICT skills and knowledge.
- ◆ Only one Australian school system has in place a process to provide certification at a specific level of ICT skills and knowledge during the years of schooling.
- ◆ Other systems have programs in place or under development to ensure that all students are assessed against standards in specific areas of ICT skills and knowledge and the outcomes reported to parents.
- ◆ At this stage, only one system is developing a strategy to aggregate assessment data on ICT skills and knowledge across schools.
- ◆ Systems have identified specific matters that need to be addressed in developing a national monitoring system for student attainment of ICT skills and knowledge:
 - agreement on terminology and definitions;
 - agreement on assessment criteria;
 - the capacity of teachers to assess ICT skills and knowledge, with attendant implications for teacher professional development; and
 - the validity of inter-system comparisons in student achievement.

National & International Initiatives

There are a number of international and national developments in assessing, monitoring and researching ICT skills and knowledge that is of direct relevance to the development of a national system of monitoring in Australia.

- ◆ ICT skills and knowledge are characterised by their relative ‘infancy’ compared to the ‘mature’ position of knowledge, practice and assessment of teaching and learning in literacy and numeracy.
- ◆ The relevance of specific ICT skills and knowledge is driven by a high level of technological change that results in continuous revision of what counts as both ‘basic’ and ‘advanced’ skills and knowledge in the field.
- ◆ National monitoring and assessments of ICT skills and knowledge to date have employed weak methodologies, based on self-report measures —

research and monitoring experience has indicated that such methodologies may not be sufficiently valid and reliable for national monitoring purposes.

- ◆ The focus of international studies is principally on the potential of data on ICT use in the learning environment, and the access and attitudes of students to ICT, to elucidate the factors influencing computer-based assessments of achievement in other domains (literacy, numeracy, science and other core curriculum areas), rather than cross-national assessment of achievement against agreed standards of ICT skills and knowledge.
- ◆ Information about the ICT skills and knowledge of Australian students from cross-national studies is unlikely to be available before 2005 at the earliest. There is no agreement in existence for continuing studies to provide international comparative data, although there are ongoing discussions in a number of international organisations about the possibility and desirability of developing comparative data in relation to ICT knowledge and skills.
- ◆ The research on which this report is based was unable to locate any non-Australian school system that currently has a program for monitoring ICT skills and knowledge. Various curriculum frameworks are in existence and some systems are conducting surveys of a range of aspects of ICT usage in schools.
- ◆ The monitoring system in the Netherlands appears to be the most comprehensively developed. It focuses on access, attitudes, usage of ICT and has commissioned research to assess ICT skills and knowledge through a self-assessment approach that is not dissimilar to that used in the Australian research in this area (Meredyth *et al.*, 1999).
- ◆ The European Computer Driving Licence (ECDL) has currency in a number of European countries and is in use in the tertiary and higher education sector.
 - The ECDL uses a competency based training program and associated computer-based assessments that generate a certificate in ICT skills.
 - Internationally, the system is not widely used in the school-age population. Its main area of application is in the post-school training, tertiary and higher education sectors.

Conclusions about the Design of a National Monitoring Program

Definition of ICT Skills and Knowledge

A definition of ICT skills and knowledge needs to be adopted. This report provides the following definition: “technologies used for accessing, gathering, manipulation and presentation or communication of information”.

Domains of Assessment

The domains of assessment for a national monitoring program as:

- ◆ ICT knowledge and skills;

- ◆ attitudes about and confidence in the use of ICT; and
- ◆ access to ICT.

Curriculum Content, Skills and Knowledge

There are many different ways of classifying the content domains (skills and knowledge) for a national monitoring program. This report presents the following classification that is based on a synthesis of approaches used in curriculum documents across systems nationally:

- ◆ information management skills and knowledge — organisation, management, sourcing, storage and transfer of information;
- ◆ understanding social and ethical contexts of information use — ownership, ethics, intellectual property;
- ◆ creation skills — word processing, authoring, multi-media skills (including video, sound, graphics, etc);
- ◆ communication skills — connectivity, group processes;
- ◆ thinking tools — extending personal capacity to enhance one's own knowledge and understandings through analysis, problem solving, simulation, computation, etc;
- ◆ research and information classification skills — representation, synthesis, evaluation, interrogation of information to create knowledge; and
- ◆ creative and design skills and knowledge — using a design/make/evaluate /improve cycle to create information and communication products and models.

Access and Attitudes

- ◆ Australia's participation in current international studies provides an adequate framework for the collection of data on access to ICT and attitudes about and levels of confidence in the use of ICT for Year 9/10 students.
- ◆ The monitoring program should collect information on access to ICT (but not attitudinal information) for students in Year 5/6.

Stages of Schooling

ICT skills and knowledge should be monitored at Year 5 or 6 and Year 9 or 10. These represent two stages in the educational development of students by which they can be expected to have acquired the:

- ◆ basic building blocks of skills and knowledge to establish the basis for becoming an independent learner (Years 5/6), and
- ◆ the capacities for students to use ICT as an integral and effective component of self-regulated learning (Years 9/10).

Frequency of Monitoring

The rapid rate of change in ICT leads to the need to design a monitoring system that can track the development of the national capacity of students in relation to current ICT. This report suggests that a monitoring program commence with a two-year cycle, with consideration of a three-year cycle once the program is established.

Assessment Methodology

Recent experience and research-based evidence suggests that a multi-modal assessing strategy be employed in a national monitoring program. Key points to be taken into account are as follows:

- ◆ self-report methodologies should be used only for the assessment of student access to ICT;
- ◆ self-assessment methodologies are adequate for assessing the attitudes about and confidence of students in using ICT;
- ◆ clear assessment rubrics will need to be developed to provide criteria and a methodology for teachers to use in assessing the components of ICT skills and knowledge; and
- ◆ computer-based performance assessment should be developed, trialed and validated as the primary strategy for establishing evidence to support teacher-based judgements of student attainment in relation to the assessment rubrics.

Benchmarking and Standards

A national monitoring program will benefit from the establishment of:

- ◆ achievement standards that are aligned with the National Goals; and
- ◆ Australian participation in international benchmarking studies of students' ICT skills and knowledge over the next decade.

Reporting Framework

The national monitoring program will need to establish a reporting process through the Annual National Report and provide all participating schools with a detailed report on the performance of their students in a timeframe that ensures the information is of value to schools.

Sampling Fraction and Cost

- ◆ Although full national population assessment would serve a wider range of purposes than a sampling approach it would be more costly and represent a significant additional task for schools. A random national sample will meet the need of monitoring progress against the National Goals for Schooling.
- ◆ The impact of the program will be enhanced if there is provision for the expansion of the sample to allow over-sampling of small sub-populations, and, where not formally selected in the sample, to allow parents and/or

schools to elect to have their children/students at Years 5/6 and 9/10 included in the assessment framework. If there is sufficient demand from schools and parents, the Year 9/10 assessments could be developed further to provide the basis for school-based certification of the ICT skills and knowledge of students.

Timeframe

There is a strong imperative to undertake the first phase of a national monitoring program next year. The following program cycle is suggested as a means of meeting this need and establishing the program for the longer term:

- ◆ develop the assessment procedures and design for a monitoring program in the first three terms of 2001;
- ◆ undertake a first cycle of the program of national monitoring in Term 4, 2001; and
- ◆ undertake the second cycle of the program of national monitoring in Term 4, 2002.

Supporting Resources and Professional Development

The national monitoring program will be substantially enhanced if:

- ◆ all schools are provided with access to the performance assessment tasks and assessment rubrics following each assessment cycle; and
- ◆ a program of professional development is provided to ensure that teachers undertaking the assessments are aware of the processes and have the requisite knowledge base to ensure that the assessments are both valid and reliable.

Further Research & Development Required

The impact of ICT on student learning in core curriculum areas will not be assessable from the monitoring program and there will, therefore, be a need to assess:

- ◆ the impact of ICT on learning outcomes and processes through the commissioning of appropriate research studies; and
- ◆ the impact of likely changes in technology over the foreseeable future on the specification of the ICT skills and knowledge.

MONITORING INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) SKILLS AND KNOWLEDGE

SECTION 1: PURPOSE OF THE REPORT

In April 1999, State, Territory and Commonwealth Ministers of Education met as the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) in Adelaide. At that meeting, Ministers endorsed a new set of National Goals for Schooling in the Twenty-First Century. The new goals were released in April 1999 as The Adelaide Declaration (1999) on National Goals for Schooling in the Twenty-First Century.

At the same meeting MCEETYA affirmed its commitment to national reporting of comparable educational outcomes and agreed that “the Common and Agreed National Goals for Schooling in the 21st Century” provide an appropriate framework for such reporting. To this end, in April 1999, it established the National Education Performance Monitoring Taskforce (NEPMT) to, *inter alia*, develop key performance measures as the basis for national reporting in the agreed areas of schooling, one of which is *information technology*:

The present report was commissioned by the NEPMT to provide advice to assist its deliberations in the development of key performance measures to monitor the changing national profile of information and communication technology (ICT) skills and knowledge of Australian school students. This report:

- ◆ describes the context in which ICT skills and knowledge are among the essential outcomes of schooling;
- ◆ identifies and describes the performance measurement approaches, definitions and sources of data currently used by school systems and authorities, the VET system in Australia, researchers and national and international agencies for reporting on ICT skills and knowledge;
- ◆ evaluates the ICT measures currently in use for their appropriateness in describing ICT for purposes of national reporting within the context of the “Goals for Schooling in the Twenty-First Century”;
- ◆ develops options for measuring the changing profile of the ICT skills and knowledge of the school population, including: the most appropriate types of performance to be assessed, the comparisons to be made, the target populations, and the sampling approach to be employed;
- ◆ identifies the extent to which the proposed monitoring and assessment framework will require further work to develop appropriate definitions and an operational monitoring program; and
- ◆ provides a preliminary assessment of the relative costs and benefits to school systems and authorities of introducing the proposed program.

SECTION 2: THE CONTEXT OF ICT IN SCHOOLING

Global Economic Context

The integration of ICT into school learning environments needs to be a central plank in the improvement of the nation's technology-related earnings performance relative to other OECD nations. The integration of ICT in Australian schools is one of the nations most important economic and education policy objectives. Recent OECD statistics clearly show that in many cases Australia is among the leading group of OECD countries in terms of macro-level indicators of ICT growth and infrastructure development that set the stage for a substantially greater role for ICT in the nation's future. The statistics indicate that Australia also currently lags well behind most countries in its earnings from technology and knowledge-based activities.

Recent benchmarks for knowledge-based economies (OECD, 1999) show that Australia ranks among the leading OECD countries in relation to:

- ◆ real value-added growth over the last decade;
- ◆ expenditure on ICT as a percentage of GDP;
- ◆ household PC penetration;
- ◆ secure web-servers per capita;
- ◆ R&D expenditure as a percentage of GDP;
- ◆ researchers per thousand of the workforce; and
- ◆ the rate of scientific publications.

Areas where Australia lags behind the average for OECD nations include:

- ◆ investment in education as a percentage of GDP;
- ◆ investment in the knowledge economy as a percentage of GDP;
- ◆ percentage of earnings from technology-based activities; and
- ◆ technology related trade.

Australian Education Context

The importance of education to the information economy has been recognised at government level in Australia through Priority 2 of the Strategic Framework for the Information Economy, which aims to “deliver the skills and education Australians need to participate in the information economy” (Commonwealth Ministerial Council for Information Economy, 1998).

Subsequently, an education Action Plan for the Information Economy have been developed — one for the school education sector and one for the education and training sector. The key action areas for both plans are people, infrastructure, content and services, supporting policies, and enabling regulation.

The information economy goals for schooling articulate with the National Goal for Schooling that relates to students being “confident, creative and productive users of new technologies, particularly information and communication technologies, and understand the impact of those technologies on society” (National Goal 1.6). Performance monitoring of student ICT skills and knowledge as part of the monitoring of the National Goals for Schooling will form part of the monitoring of the School Education Action Plan for the Information Economy.

The National Goals of Schooling

The preamble to the *National Goals for Schooling in the Twenty-First Century* specifically acknowledges the place of technology in the modern world. “These national goals provide a basis for investment in schooling to enable all young people to engage effectively with an increasingly complex world. This world will be characterised by advances in information and communication technologies...” (MCEETYA, 1999)

The National Goals imply a broader imperative than the economic. The effective use of ICT in schools is expected to have a beneficial impact on teaching and learning (Meredyth *et al.*, 1999: p12) but it is also increasingly evident that the ubiquitous role of ICT in everyday life, from personal banking to entertainment (Ainley *et al.*, 2000) is establishing ICT skill as a new literacy or basic living skill.

Table 1 describes the National Goals that provide the backdrop for the monitoring of ICT skills and knowledge of Australian school students.

The evaluation of progress towards the attainment of the National goals requires a program of monitoring of ICT knowledge and skills in relation to Goals 1.6, 2.1 and relevant vocational courses within 2.3.

There will be a need to take account of progress in the development of ICT skills and knowledge of *specified subgroups* (according to sex, gender, language background, culture and ethnicity, religion, disability, socio-economic status, geographic location, and the progress of Aboriginal and Torres Strait Islander students) (Goals 3.1, 3.2 & 3.3).

The achievement of other goals, including analysis and problem solving skills, communication and planning abilities, capacity to collaborate, exercise judgement and make sense of the world, as well as opportunities to develop self-confidence and self-esteem (Goals 1.1–1.6) will also benefit from the acquisition of ICT skills and knowledge.

Table 1: National Goals relevant to the monitoring of ICT skills and knowledge

Area	Goal Number	Goal
Talents and capacities	1.1	Students develop a capacity for analysis and problem solving, ability to communicate ideas and information, to plan and organise activities and to collaborate with others.
	1.2	Students have qualities of self-confidence, optimism, high self-esteem.
	1.3	Students have the capacity to exercise judgement and the capacity to make sense of the world.
	1.5	Students have employment-related skills.
	1.6	Students are confident, creative and productive users of new technologies, particularly information and communication technologies, and understand the impact of those technologies on society.
	Curriculum	2.1
2.3		Students participate in programs of vocational learning and have had access to vocational education and training programs.
2.4		Students participate in programs and activities that foster and develop enterprise skills.
Social Justice	3.1	The outcomes of schooling free from negative discrimination based on sex, language, culture and ethnicity, religion or disability, and of differences arising from students' socio-economic background or geographic location.
	3.2	The learning outcomes of the educational disadvantaged improve over time and match those of other students.
	3.3	Aboriginal and Torres Strait Islander students have equitable access to and opportunities in schooling.

Advice in Relation to the Establishment of a National System for Monitoring ICT Skills and Knowledge

- ◆ The context in which any program of monitoring of ICT skills and knowledge will be developed and executed is a world in which the confluence of information technology, communications and knowledge will be one of the major influences on economic and social life.
- ◆ The emergence of this context is recognised in national policy documents and processes — in which education is viewed as a fundamental part of the infrastructure of future social and economic prosperity.
- ◆ The National Goals for Schooling articulate a set of outcomes that will be required by citizens in a knowledge-based society.
- ◆ The imperative for high quality ICT skills and knowledge is particularly pertinent as we move from an industrial to a knowledge-based society.
- ◆ The ICT skills and knowledge envisaged as necessary in a knowledge-based society are not simply the functional skills required to 'operate'

computer technology, information and communications systems, but deeper knowledge structures and models that provide the basis for interpreting and accessing the social and economic opportunities of such a society.

- ◆ The equitable distribution of ICT skills and knowledge across all sections of society will be an important aspect of ensuring access to social and economic opportunities for all sub-groups in the population.
 - ◆ ICT skills and knowledge will contribute both directly to the attainment of specific National Goals and indirectly to the attainment of others.
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SECTION 3: SURVEY OF RELEVANT RESEARCH

The application of technology in the classroom is still seen by many Australian teachers as an optional extra, an 'add-on', rather than an integral part of everyday teaching and learning. Many Australian teachers lag behind their students in the acquisition of skills and knowledge in the understanding of advanced skills in the use of ICT (MCEETYA, 1997).

One of the most frequently noted research findings in relation to learning outcomes is that increased learner engagement, self-confidence, collaboration, expression, global understanding, higher-order thinking and independent learning can be associated with the use of ICT (Dunbar *et al.*, 2000).

The UK National Council for Educational Technology (1994) concluded that the effective use of information technology:

- ◆ provides flexibility to meet the individual needs and abilities of each student;
- ◆ reduces the risk of failure at school;
- ◆ provides students with immediate access to richer source material;
- ◆ presents information in new and relevant ways which helps students to understand, assimilate and use it more readily;
- ◆ enhances learning for students with special needs;
- ◆ motivates students to try out new ideas and take risks;
- ◆ encourages analytical and divergent thinking;
- ◆ helps students learn through well-designed, meaningful tasks and activities; and
- ◆ offers potential for effective group work.

It is frequently argued that the use of computers in the classroom increases student motivation in a variety of ways, including increased enjoyment, increased control and increased access to information (Rowe 1993; Joiner 1996; Wellburn 1996; Tierney, 1996). Computers can create lively forums of joint activity that are productive and lead to (group) products that are superior to whatever could be created by the participants alone. The computer activities "serve as an occasion for classroom discourse: a setting in which certain kinds of potent socially organised experience can be arranged" (Crook, 1994: p98).

An ACER study of laptop computer use in a Melbourne school found that laptops used in learning will not guarantee strong learning outcomes, but there are a "variety of ways in which the computer becomes part of and influences how students are connected with their learning" (Ainley *et al.*, 2000: vii). Using the metaphor of the computer as a 'tool' the ACER study described five perspectives on the use of computers:

- ...a tool for getting school work done.*
- ...a tool with its own special procedures to learn*
- ...a tool for access to knowledge and information.*

...a tool for presentation of work.

...a tool for playing games. (Ainley *et al*, 2000: p16)

Drawing on the work of Sproull and Kiesler (1991), Lankshear *et al* (1997a: p48) argue that introducing technologies can have ‘first and second level effects’. Planned or expected benefits such as improved learning and stronger student motivation are referred to as first–level effects. Second–level effects are generated by ICT creating new contexts and environments of practice that change work patterns, roles, procedures, perceptions of work possibilities and organisational groupings.

New technologies change the “social practices within which they are used, with the result of changing the way people talk and think about them”. Learning in the traditional sense was based on the notion of nested boundaries — the “fixed enclosures of the book, the classroom, and larger curriculum structures” (Lankshear, *et al*, 1997a: 48). However, as both teachers and students have noted, the introduction of ICT into learning environments has led to significant changes in each of those enclosures, a different sense of space and interactions for learning, and changes to the temporal dimension in which this learning takes place. Much learning occurs outside class-time, and the diverse application of ICT has created a greater number of pathways to support learning.

Many Australians, especially children, now take the home computer for granted. Almost 50% of all Australian households have access to a computer regularly (Australian Bureau of Statistics, 1999). Internationally, there was a 400% increase in the number of interconnected computers – 50 million users linked around the world in the period 1992–95 (Employment and Skills Formation Council, 1995).

We have entered an age when computer based technology and telecommunications have affected virtually every institution in our culture and connected us with other cultures across the globe. To send young adults into a global community without knowing why, when and how to use these emerging technologies is unthinkable. This perspective stresses the need for young people to know how to use ICT, but also their need to develop the higher–order thinking and problem solving skills necessary to exploit the opportunities provided by ICT (Blanton *et al*, 1998).

In their Report to the President, the Panel on Educational Technology (1997) described a somewhat bleak picture of the problems in American schools are having with accessing and using technology. They found that, while the ratio of computers per student had increased considerably, most school computers lacked adequate hard drives, were not networked locally or to the Internet, and were isolated in labs rather than in classrooms. There was little technical support, with fewer than 5% of schools having a full time computer coordinator. The lack of effective staff development and initial teacher education in the implementation and application of computer technology compounds the problems faced by schools.

A National Sample Study of Information Technology Skills (NSSITS) of Australian school students (Meredyth *et al.*, 1999) found that students enjoy using computers at school and are confident of their skills, especially in comparison with their teachers. Students, particularly those in urban areas, believe that computer skills will be important for future work and study.

Nearly all the students surveyed had acquired the basic information technology skills such as using a mouse, turning on a computer, using a keyboard, saving and printing documents, creating and moving files and getting data from disks and CD-ROMs. Sixty-seven percent of the students surveyed said they had acquired all of the basic skills. More than half the students surveyed had a range of advanced information technology skills such as connecting to the web, sending eMail, and creating music or sound with computers. Forty-eight percent reported that they could create a multi-media presentation and 38% reported they could make a web page. The study reported that the basic skills of students are equivalent to those of their teachers and that their advanced skills are well in advance of their teachers.

The study also found that students' advanced information technology skills tend to be acquired at home rather than at school. Eighty-five percent of students reported using computers outside of school. Eighty percent had a computer at home and over a third had a printer and modem. The report linked technologically enhanced home environments with an enhanced capacity to acquire ICT skills and knowledge.

The study demonstrated a number of disparities in information technology skills among young people. Indigenous students and those from small, generally rural, schools reported less advanced skills. Students from independent and single-sex boy's schools reported the most advanced skills. Girls lagged behind boys in acquiring advanced information technology skills.

The information technology resources of schools were found to impact on student learning. Where student-to-computer ratios were advantageous, students were more confident about their own basic and advanced skills and more likely to report that they enjoy using computers at school.

The Innovation and Best Practice Project (IBPP) funded by the Commonwealth Department of Education Training and Youth Affairs (DETYA) documented the findings of 107 innovative school projects of which 25 had a focus on technology innovations. The reports from the project¹ provide evidence that schools are beginning to use information and communication technology infrastructures as the 'glue' that supports teaching, learning and administration. In this context, schools viewed ICT as a set of tools and an enabling framework to amplify, extend and transform learning and to provide the latitude, understandings, resources and skills to do so by extending the school into the local community.

¹ It is expected that the reports from the project will be published towards the end of this year.

The project also documented the way in which ICT is being used to develop students as critical and strategic thinkers and problem solvers with the capacity to negotiate and design specific aspects of their learning program, including the assessment criteria for it. There is evidence that ICT is being used to improve the non-cognitive aspects of learning by enhancing the engagement of students in their learning; improving the capacity of students to negotiate their learning experiences and outcomes; developing communication skills and the competencies to collaborate and interact as members of learning teams; improving students' understanding of cultural and social stereotypes and the implications of these; and developing student's awareness of their preferred learning styles and the impact of different teaching strategies on learning.

A heuristic classification of the possible range of applications of ICT in schools that is used in the research literature is the following.

- ◆ Learning *about* ICT is the focus of the IT curriculum in most school systems. It targets the acquisition of basic ICT and knowledge, such as the skills of using a computer to do basic word processing and to print documents. It may also provide the student with basic knowledge about the role of ICT in the workforce and society more generally. The focus is on what ICT is, rather than how to use it in the processes of learning.
- ◆ Learning *with* ICT takes the form of using technology to access resources through research on the internet, communication that integrates material and ideas from a range of sources and media, using simulations to replace real-time 'experiments', using graphical calculators to teach calculus, etc. Some schools also use on-line learning projects in which software supplements text-based resources. In many such cases, schools seek to use technology as a learning medium to improve the engagement and motivation of students.
- ◆ Learning *through* ICT involves restructuring the organisation of teaching and the nature of learning to take account of the enhanced capacity that ICT offers to access, integrate and model information from a range of sources and to use communication networks to interact with other learners. In many cases this takes place in the context of the development of student's meta-cognitive learning skills and is often associated with the adoption of a 'constructivist' approach to teaching and learning. Technology is utilised to mediate learning, but there is little or no focus on learning *about* the technology or using the technology as a strategy to simply extend standard teaching practices.

Schools that use ICT to teach students *about* and *with* technology are likely to observe 'first-level' effects while those seeking to teach students *through* technology are more likely to observe 'second-level effects on learning.

Advice in Relation to the Establishment of a National System for Monitoring ICT Skills and Knowledge

The forgoing has provided an outline of research findings that highlight the changing environment in which the program for monitoring ICT knowledge and

skills of students will be introduced. The main implications for a monitoring program are the following.

- ◆ Effective ICT learning environments in schools impact on a range of cognitive and non-cognitive outcomes for students.
- ◆ ICT has been shown to impact on cognitive learning outcomes, including:
 - curriculum specific knowledge;
 - ICT skills and knowledge; and
 - higher-order thinking and meta-cognitive skills.
- ◆ Research has also shown that effective ICT-based learning environments can have an impact on a range of non-cognitive learning outcomes, including:
 - work-place competencies, such as the capacity to work in teams;
 - social behaviours, such as cooperation and social acceptance of others; and
 - affective development, such as self-esteem, motivation and a sense of purpose.
- ◆ There is evidence that schools develop their ICT environments through a series of stages in the use of ICT:
 - initially seeking to teach students about ICT, but
 - subsequently seeking to integrate it across the curriculum as a means of providing learning environments that allow students to learn with ICT; and
 - full integration is achieved when learning takes place through ICT. In this final stage, ICT potentially has the capacity to play a significant role in the transformation of learning by reshaping teachers' and students' knowledge of the processes of thinking and learning.
- ◆ The acquisition of ICT skills and knowledge takes place both inside schools and outside schools.
- ◆ Self-report survey data indicates that a high proportion of young persons believe they have acquired a wide range of 'basic' and a number of more 'advanced' ICT skills before they leave school.
- ◆ Compared to teenagers, teacher self-report survey data suggests that a lower proportion of them have acquired 'advanced' ICT skills.
- ◆ Survey data indicate significant disparities in the acquisition of ICT skills among sub-groups of young persons, with lower levels of skills being evident for indigenous students, girls and those living in smaller and rural communities.

SECTION 4: SURVEY OF AUSTRALIAN SCHOOL SYSTEMS

This section on systemic practices in Australia reports on:

- ◆ student access to ICT in schools;
- ◆ current approaches to ICT skills development and their alignment to the National Goals;
- ◆ current and past assessment by individual systems of ICT in schools and plans to monitor ICT skills of students in the future; and
- ◆ issues identified by systems in relation to a program of national monitoring and reporting.

Methodology

In December 1999 a letter was sent to the CEOs of all state education systems and the CEO of Catholic Education Commissions in each state. The letter informed systems of this project to develop advice for the NEPM Taskforce on key performance measures to monitor progress in the ICT knowledge and skills of Australian school students within the context of the National Goals for Schooling in the Twenty-First Century. Education systems were invited to contribute relevant information to the development of the discussion paper via a series of survey questions (Refer Appendix A) and to nominate a liaison officer for the project. The survey sought to identify current or planned approaches to the monitoring of ICT skills and knowledge of students.

Responses were received from seven of the eight government education systems and four Catholic systems. Catholic systems generally indicated that they regarded the monitoring of ICT skills and knowledge as a school and not a systemic issue. They indicated that their role is one of policy coordination rather than the monitoring of student standards. The Catholic systems that responded to the survey did, however, report on relevant practices occurring within their systems.

The planned monitoring of the National Goals of Schooling also has the same implications for all sectors. The National Director of the Australian Independent Schools association was consulted and a similar letter to that sent to state and Catholic systems was forwarded to each state association of independent schools, informing them of the project and inviting them to contribute as they saw fit. Three responded, indicating that without surveying individual schools they were not in a position to respond.

Education systems were provided with earlier drafts of this report as it was prepared and invited to comment on, amend or add to sections as appropriate. Their responses have been incorporated into the final report.

Student Access to ICT in Schools

Each State and Territory government in Australia has articulated a commitment to increased access to computers, internet access for all schools, professional development for teachers and increased networking opportunities for schools.

Currently in Australia:

- ◆ 71% of schools have a student–computer ratio of 15:1 or less and this ratio is decreasing each year;
- ◆ 37% of the computers in schools are in laboratories and 31% in classrooms;
- ◆ laptop computers comprise 16% of all computers used for educational purposes in schools—most of these are in the non-government school sector;
- ◆ secondary schools generally have lower student–computer ratios than primary schools;
- ◆ secondary schools are more likely to place computers in laboratory settings and offer specific ICT courses rather than integrating their use in classrooms across the curriculum;
- ◆ most computers in Australian schools used for educational purposes run at 100MHz or faster with access to printers, modems, scanners, file servers and digital cameras; and
- ◆ common applications in schools include integrated packages, reference CDs, educational games and virus protection. Few schools have multimedia creation applications (Allan, 2000).

Current Approaches to ICT Skills Development

Consistent with the National Goals, most education systems have two curriculum strategies that focus on the development of ICT skills and knowledge of students. The first promotes the acquisition of ICT knowledge and skills across the curriculum by all students from the first to last year of schooling, and the second is to develop curriculum frameworks for specific courses of study in designated specialist areas of ICT.

A number of systems have published curriculum or policy documents setting out expectations for the acquisition of ICT knowledge and skills. For example, the Department of Education in Queensland (1995) published *Guidelines for the Use of Computers in Learning* which set out aims and goals, discussed the application of technology in various curriculum areas, and provided guidance on teaching and learning, classroom management and evaluation. The Board of Studies in Victoria recently published its Curriculum and Standards Framework Version 2 (CSF2) for the Technology KLA which describes expected learning outcomes, including those relating to ICT, for all students at each stage of schooling.

The ACT Department of Education and Community Services provides guidelines in relation to five broad ICT competencies with accompanying performance criteria. The majority of systems indicated a preference for the development of ICT skills to be integrated into all learning areas in a cross-curricular approach, as opposed to an alternative approach of developing a separate ICT curriculum applicable to all students.

The second curriculum strategy focuses on the provision of specific courses of study for areas of specialist ICT related knowledge and skills in the secondary years. A range of vocationally-oriented courses are covered by this category. For example, in New South Wales, relevant Board of Studies syllabuses include Computing Studies 7–10; Software Design and Development 11–12; Information Processes and Technology 11–12; Information Technology (VET in Schools) 11–12.

Vocational Education and Training (VET) courses are part of the Australian Qualifications Framework (AQF) in which qualifications in the secondary school sector are awarded at AQF Level 1 or 2. Endorsed VET courses specify competency standards, performance criteria and guidelines for assessing the standards. These are linked to national AQF Certificates under the Australian Recognition Framework.

Whilst the development of integrated general skills and courses focusing on specialist skills are both relevant to the provision of opportunities to develop ICT skills and knowledge, the National Goals can be interpreted as differentiating between the two. The first strategy focuses on developing and monitoring the general ICT knowledge and skills of all students, in a similar way to that in which schools are concerned with developing and monitoring literacy and numeracy skills. The national goals in relation to the second curriculum strategy, ie. courses of study in specialist ICT areas focus attention on participation in vocational courses.

Whilst both are relevant to any monitoring of progress towards the attainment of the National Goals, the focus of this report is predominantly on issues associated with the monitoring of general ICT skills and knowledge across Australian school students as a whole, ie. in alignment with the first curriculum strategy. The Australian Council for Computers in Education has indicated that it also supports the inclusion of specialist vocationally-oriented skills and knowledge in any monitoring program.

Assessment and Monitoring of ICT Skills and Knowledge

Limited evaluation of student ICT skills has taken place to date in States and Territories. The evaluations that have been undertaken have been designed to provide feedback in relation to policy directions and information to assist further development. State and Territory departments of education have provided the following information on developments that relate directly to the assessment and monitoring of ICT skills and knowledge.

Victorian Department of Education, Employment and Training (DEET)

The current data on student ICT skills and knowledge are based on teacher assessments of student achievement against learning outcomes in the Information strand for Technology in CSF2.

The assessment information is retained at the school and used for reporting to parents. It is not collated centrally and under current arrangements would not be available for national performance monitoring.

Other relevant information includes:

- ◆ longitudinal survey data on classroom uptake of ICT and the level of software use in schools;
- ◆ data on the volume of internet traffic from schools to indicate behavioural change; and
- ◆ data on student access to computers and networks, indicating opportunities to include technology in teaching and learning.

DEET has commissioned evaluations of the Navigator Schools program, and the Teacher Notebook initiative and is participating in a joint project with the Australian Research Council on the integration of ICT in the teaching in Science and SOSE across Years 5–8.

DEET recently published an ICT Strategy that proposes to develop measures of student performance against specified learning outcomes related to the use of ICT. Performance measures will be developed through current and proposed research projects. Assessment of student ICT skills will be based on teacher judgements against specific performance criteria with some student self-assessment.

Queensland Department of Education

The Queensland Department of Education surveys staff and parents, and students in Years 5, 7, 9 & 11 on their satisfaction with: student opportunities to use computers; the development of student computer skills; and the way computers are used at school. The computer-related questions comprise 3 items, each with a five-category response option, in a survey of 20–30 items. The survey is conducted annually in all schools, although sampling of students occurs in larger schools.

In 1997, the department also surveyed the ICT skills of a cross-section of students in Years 6 and 7 in State schools. This provided a snapshot of skills across the system and was used to determine the success of the Years 6–7 Primary Computer Program, inform submissions for future funding, and identify issues that needed to be addressed in future developments. The evaluation included teacher and student surveys and interviews. Student skills were assessed through self-reports using a 'pencil-and-paper' instrument.

The department is developing the New Basics Project that includes an integrated framework defining essential areas of learning (New Basics), appropriate and

effective approaches to teaching (Productive Pedagogies) and affiliated modes of assessment (Rich Tasks). Elements of the Rich Tasks have a technology component.

South Australian Department of Education Training and Employment (DETE)

The South Australian Department of Education Training and Employment (DETE) plans an annual assessment from the first year of schooling to Year 10 against the South Australian Curriculum Standards Accountability (SACSA) framework. ICT outcomes are to be highlighted in the technology learning area and will be made explicit where appropriate within the other learning areas. Processes for assessing and monitoring these competencies will be trialed in 2000.

In addition to general ICT competencies the department plans to develop and implement the monitoring of keyboarding competencies in 2000/2001. Assessment of keyboarding will begin at Year 4 and will continue through subsequent years of schooling. Profiling of ICT skills and knowledge of all Year 9 students will be undertaken through an audit process and an industry recognised ICT certificate will be developed for Year 10. Compass-Assessware is being trialed in 2000 as the audit tool.

Education Department of Western Australia

The Education Department of Western Australia plans to monitor knowledge and skills of a sample of students in Years 7 & 10 commencing in September 2000. Tasks will be based on criteria in the Outcomes and Standards Framework. Evaluation will be based on 'extended performance tasks'.

The achievement profile in 2000 will provide baseline data for future assessments. A component of the assessment will be based on teacher observation of performance against set criteria. In addition to teacher observation, performance tasks will be centrally marked, with attention to the issue of reliability. A public report will be produced on the outcomes of the monitoring program. Students in Year 7 will complete one performance task and those on Year 10 will complete two performance tasks. The Year 10 assessment is expected to be undertaken over a week in up to 200 minutes of class time.

ACT Department of Education and Community Services

The Australian Capital Territory is introducing an ICT competency certificate for Year 10 students in 2000. By 2001 it aims to have 95% of Year 10 students achieving certification. Assessment is based on criteria that are implied and embedded in a number of departmental curriculum documents.

Student competence will be assessed by teachers. Teachers will assess against a matrix of student ICT skills across the curriculum. Students need to demonstrate their competence once only, although future developments may require them to demonstrate their competency in a range of contexts, to assess transferability of

skills. Further development work is planned to link the skills and knowledge in the certificate to the tertiary sector, employers and the national training framework.

Among the findings of a pilot study conducted in 1999 were:

- ◆ students and teachers often had no common formal language to describe competencies, because they had learnt skills and computer applications from informal sources; and
- ◆ students achieved better results in all competencies and at all levels in schools where more teachers were able to report appropriately on student competency.

A computer-based reporting mechanism has been developed to collate results entered by individual teachers. The program includes options allowing teachers to print interim reports for students and teachers to use in monitoring progress towards completion of requirements, parent reports and official certificates of attainment.

An interactive multimedia assessment tool will be developed during 2000 to provide an additional assessment method, although it is not anticipated that this will be capable of assessing all aspects of the competency framework, eg. collaborative teamwork.

Issues to be Addressed in the Development of a National Monitoring Program

Three particular areas were identified by systems as requiring particular attention in the development of a program of national monitoring:

- ◆ common assessment criteria and terminology;
- ◆ the capacity of teachers to assess ICT skills and knowledge;
- ◆ the validity of any comparisons, given the uneven distribution and access to ICT resources within and across systems.

Common Assessment Criteria and Terminology

At a general level, systems report that the objectives of their curriculum documents and the National Goals are mutually supportive.

Only the ACT currently specifies the ICT skills and knowledge that students are expected to acquire by year-level. Some systems specify outcomes in progression levels, similar to or aligned with the previously developed National Profiles (eg. Vic., WA), while others provide teachers with guidance on directions and goals but do not specify expected learning outcomes at specific levels of schooling (eg. QLD, Tas.).

Systems do not use the same terminology in their policies and publications about ICT. The Technology Education Federation of Australia (TEFA) has recommended that the term 'information technology' in education contexts be "used to refer to computers and related learning technologies" (TEFA, 1998).

Teacher's Capacity to Assess Student ICT Skills and Knowledge

There is ample evidence (see for example Meredyth *et al.*, 1999) that teacher ICT competencies are often at a lower level than that of their students. This can create difficulties when teachers are required to assess student competencies that are above their own level of skills or knowledge. All systems and sectors have made teacher professional development in ICT a priority. A number of systems have also specified teacher competencies and some have set in place systems of accreditation to encourage the improvement of teacher professional competence.

Validity of Inter-System Comparisons

Systems report that the fairness and the validity of any inter-system comparisons is an issue given the uneven distribution and access to ICT.

Systems do not view the reporting of outcomes by sub-group as particularly problematic. They are familiar through national reporting of literacy and numeracy outcomes with structures for reporting by year-level, gender, Aboriginality, and NESB status.

Advice in Relation to the Establishment of a National System for Monitoring ICT Skills and Knowledge

The current and emerging practices, policies and programs of Australian school systems can be characterised as follows.

- ◆ They recognise both the broad based ICT skills and knowledge that all students need to acquire and more specialist skills and knowledge that students planning ICT specific post-school vocational pathways need to acquire.
- ◆ VET in schools programs and in post-school contexts provides certification at a number of levels in specific areas of ICT vocational skills and knowledge.
- ◆ There is no clear evidence that students following non-ICT pathways in post-school VET programs are systematically being provided with opportunities to acquire ICT skills and knowledge.
- ◆ Most systems already have or are developing an ICT skills and knowledge focus in support documents and assessment regimes across the curriculum.
- ◆ Only one Australian school system has in place a process to provide certification at a specific level of ICT skills and knowledge during the years of schooling.
- ◆ Other systems have programs in place or under development to ensure that all students are assessed against standards in specific areas of ICT skills and knowledge and the outcomes reported to parents.
- ◆ At this stage, only one system is developing a strategy to aggregate assessment data on ICT skills and knowledge across schools.

- ◆ Systems have identified specific matters that need to be addressed in developing a national monitoring system for student attainment of ICT skills and knowledge:
 - agreement on terminology and definitions;
 - agreement on assessment criteria;
 - the capacity of teachers to assess ICT skills and knowledge, with attendant implications for teacher professional development; and
 - the validity of inter-system comparisons in student achievement.
-

SECTION 5: NATIONAL AND INTERNATIONAL INITIATIVES

Methodology

A number of national and international studies that have been completed or are in progress have the potential to provide valuable information on approaches to assessing and reporting on the ICT skills and knowledge of Australian students.

An electronic search methodology was employed to locate and mine relevant Internet sites associated with national and international initiatives. Programs and initiatives in countries considered to have education systems and aspirations with elements common to Australia were chosen for further study. In addition, members of the NEPMT sub-committee on information technology and school systems provided access to sources for much of the Australian information that was accessed. Up-to-date information on a number of emerging international initiatives was obtained through electronic communication with members of the respective international project development teams and from Australian representatives on various committees associated with these developments.

National Monitoring of Literacy and Numeracy (Australia)

ICT, literacy and numeracy share the value that they are each considered to be integral and basic components of the skills and knowledge that young people need to acquire before they can engage in independent learning or the acquisition of higher-order thinking and cognitive processing skills, or in the acquisition of propositional knowledge. Hence, they are appropriately the subject of national monitoring to assess whether students have attained standards that are considered necessary to competently advance through the middle and later years of schooling.

Programs for the monitoring of literacy and numeracy have been in place in most Australian school systems for some years. Literacy and numeracy draw on well-established curriculum areas and well-developed teaching programs and methods of assessment. Although there is not unanimous agreement about which aspects of literacy and numeracy constitute 'basic' skills and knowledge, there is nevertheless widespread agreement to be found in the foundations of the various assessment programs. This has led, through a process of consultation over the last few years, to the establishment of national benchmarks for the achievement of basic skills and knowledge in literacy and numeracy.

The situation with ICT skills and knowledge is quite different to that for literacy and numeracy. Literacy and numeracy are established curriculum areas with a wide body of knowledge about effective practice and appropriate and relatively well developed skill levels among teachers. Compared to this, the ICT curriculum in schools is not yet clearly defined in all systems and there is evidence of substantial variability in skills and knowledge among teachers who are responsible for teaching aspects of ICT skills and knowledge. Whether they have the skills or not, a significant proportion of teachers do not use them or teach them in their day-to-day teaching (Meredyth *et al*, 1999).

The provision of adequate access to appropriate resources and teaching programs for literacy and numeracy has been a feature of most systems for some years, however, adequate access to fundamental resources in the form of hardware, software and communications networks for ICT is still being established in most systems.

Teacher expertise and professional development in the ICT area has become available relatively recently, while it has been available in the curriculum areas of literacy and numeracy in various forms for a number of decades and has been a major national focus of regeneration over the past five years.

Literacy and numeracy standards are now well-established and were the subjects of systems of quality assurance from the early days of the Inspectorate last century. Standards for ICT skills and knowledge are yet to be established and are influenced by the continuous advances in computing and telecommunications. This state of flux is such as to make some skills that were considered to be core basic skills in the use of computers (eg. copying a floppy disk) redundant over a 5–8 year period. The changes in specific skills and knowledge required to engage effectively in learning environments that maintain up-to-date ICT equipment presents a significant challenge to the establishment of standards that have continuing value.

National Sample Study of Australian School Students (NSSITS)

The National sample study of the information technology skills of Australian school students was recently published as *Real Time* (Meredyth *et al.*, 1999). The key findings of this study have been reported above. The study surveyed 6213 students, 1258 teachers and 222 principals in 203 schools across Australia in May 1998. The student samples were drawn from Years 6/7 and Year 10.

The survey used a ‘pencil-and-paper’ questionnaire with respondents required to tick a box on a self-rating scale. The study surveyed computer use inside and outside school (hours, type of equipment, purpose) and at school (activities, length of time, purpose of activity, assessment of skill level, etc.). The student data gathered included gender, age, year-level at school, Aboriginality, language spoken at home, and technology available at home. The demographic data about schools included extent of rurality and size of school as well as state and system/sector.

The survey focussed on student acquisition of ICT skills at ‘basic’ and ‘advanced’ levels. The study did not define basic or advanced skills, but the following exemplify the types of basic skills referred to:

- ◆ using a mouse;
- ◆ shutting down and turning off a computer;
- ◆ saving a file and opening a saved document;
- ◆ copying from a floppy disk or CDROM; and
- ◆ moving files.

The 'advanced' computer skills of students included skills such as (percentage of students who reported that they had acquired each skill in parentheses):

- ◆ using the worldwide web (65%);
- ◆ using a computer to create sound or music (58%);
- ◆ sending an eMail message (53%);
- ◆ creating a multimedia presentation (48%);
- ◆ constructing a web site/home page (38%).

Two-thirds of the students reported that they had acquired more than half of the 13 advanced skills and 22% had acquired all 13 skills. Only 15–38%, depending on the skill, of the students indicated that they had acquired each of the individual 'advanced' skills at school. All but one of the skills was more likely to be acquired by students in their home environment than in the school environment.

The methodological issues encountered by the authors in setting up the study included:

- ◆ how to develop survey instruments to cover a broad range of inquiry while keeping them simple, accessible and brief enough for primary aged students;
- ◆ ensuring that the vocabulary of the survey was able to identify skills without separating them from contextual activities; and
- ◆ finding ways to test what students could actually do rather than student knowledge of concepts.

The methodological challenges encountered in the *Real Time* study, whilst resolved for that purpose, need further evaluation in terms of their relevance to a national monitoring scheme, which is provided later in this report.

Program for International Student Assessment (PISA)

Australia is participating in the OECD Program for International Student Assessment (PISA), which has its first cycle of assessment this year. The PISA will focus on internationally standardised assessment of the achievement of 15-year-olds in the three domains of reading literacy, mathematical literacy and scientific literacy in a cross-national context. The study is being conducted in 32 countries and is the result of several years of development to ensure that the assessments are "internationally valid and take into account the cultural and curricular contexts of OECD member countries" (OECD, 2000a).

The PISA is based on the view that "modern life...require [s] an adult population which is not only able to read and write, but also mathematically, scientifically and technologically literate". In addition to internationally standardised tests of achievement designed to assess reading literacy, mathematical literacy and scientific literacy the program in 2000 will provide participating countries with an option to administer a brief survey of 25 questions about ICT.

The survey was originally developed by the US Educational Testing Service (ETS) to evaluate whether the measured achievement of students is associated with either their access to or attitudes about ICT. The questions in the survey are based on research items administered to students who were being assessed in learning English as a foreign language. The research program investigated the impact of computer-based assessment on validity and reliability of measures of achievement and its relationship to achievement assessed through other means, principally pencil-and-paper tests. ETS is evaluating the possibility of translating its predominant testing methodology from pencil-and-paper approaches to computer-based approaches. Hence, the fundamental research question they were investigating was whether the observed achievements of students are influenced by an assessment process that is entirely computer-based.

There are no formal plans to incorporate an internationally standardised assessment of ICT skills and knowledge in PISA 2000 or the next two cycles of the program in 2003 and 2006.¹

If the PISA did ultimately include a cycle that focussed on the assessment of ICT skills and knowledge, there would still be the need to develop a national program. PISA focuses on 15-year-old students only and is not specific to the curriculum and schooling context of Australia, hence, would not provide sufficient contextually based information to allow for effective monitoring against the National Goals for Schooling. Australian schools are introducing students to ICT from the early years and a program that provided information about the 15-year-old cohort of students once every 4–6 years would not suffice to provide feedback about progress towards the attainment of the National Goals.

IEA Computers in Education Studies

The International Association for the Evaluation of Educational Achievement (IEA) has conducted two studies of computers in education. The first was a two-part survey known as *Computers in Education 1*, conducted in 1989, and the second, known as *Computers in Education 2*, was conducted in 1992. These two surveys involved a representative sample of primary and secondary schools in 12 countries and sought to assess: the extent and availability of computers in schools; how computers were being used; the nature of instructional use of computers; and the impact of computers on students, the curriculum and schools. Australia did not participate in these studies.

Computers in Education 1 and *Computers in Education 2* included a functional information technology (FIT) test, an elementary programming test, a word processing performance test and an attitude scale. The FIT test faced the “threat of test obsolescence as well as philosophical differences...[The test procedures

¹ The PISA program is giving consideration to the development of an assessment strategy for some aspects of ICT skills and knowledge, however, the earliest that any development in this area could be incorporated into the monitoring cycle would be in 2006.

were developed to] serve as guideposts for research and planning in computer education.” (Pelgrum *et al*, 1993)

A second study, known as the *Second Information Technology in Education Study* (SITES), is being conducted as three modules: Module 1 (1997–1999), Module 2 (1999–2002) and Module 3 (2003–2005). Module 1 (M1) described the state of ICT implementation, as at the end of 1988, in the middle primary, lower and upper secondary levels. Australia did not participate in this Module.

SITES Module 2 (M2) has three study goals:

- ◆ examine the different ways that ICT relates to school reform and under what conditions it functions as a catalyst for reform;
- ◆ uncover the critical variables that relate to successful implementation of school reforms and effective ICT; and
- ◆ detect undesirable impacts of ICT upon school functioning and student learning. (OECD, 2000b).

Australia is participating in the fieldwork data collection for Module 2 (M2), which is currently being undertaken. It consists of “a series of case studies at the three educational levels of schooling that identify and describe innovative pedagogical practices that use information and communication technology.” (NZ Ministry of Education, 1999).

Module 3 (M3) will involve a survey of teachers and students and is planned as a continuation of Modules 1 and 2. The earliest M3 will take place in 2004. IEA is currently considering the methodology and content of M3, but it will probably contain some assessment of ICT skills and knowledge based on a set of test items that can be agreed across the participating countries. Further, it is likely that the study will focus on the later years of primary and the middle years of secondary schooling.

As with the PISA, the contextual relevance of the test items to Australian curriculum and the National Goals will be unknown until an appropriate mapping and alignment process can be undertaken. The study is not currently designated to be a repeating cycle of studies, hence, it is unknown at this stage whether M3 will provide a time series of information for comparing Australian students with their peers internationally.

The development work for M3 is being undertaken jointly with the OECD Centre for Educational Research and Innovation (CERI) and is described below.

CERI Program on ICT and the Quality of Learning

This program is concerned with exploring the implications of ICT for education and learning and revolves around networks of interest related to Quality Assurance, Public–Private partnerships, and Research and Evaluation.

Thus far the program has not undertaken any studies of ICT in schooling. The focus of the program in terms of ICT has been directed towards cooperation in

the development of the IEA SITES Modules described above, particularly the development of a framework for Module 3.

Module 3 is still in an early design stage, however, one proposal from the CERI program is for a study of the “relationship of student use of various types of ICT and their ICT and self-study abilities...questions [to be addressed] include:

- ◆ the depth and range of ICT knowledge that students are obtaining from ICT use inside and outside the classroom;
- ◆ whether more ICT use necessarily leads to more positive attitudes towards ICT as a learning tool;
- ◆ how increased ICT use is impacting learning-to-learn skills, and
- ◆ whether gaps in ICT use based on income level or other factors are leading to similar gaps in information processing.” (OECD/CERI, 2000)

The proposed methodology is for a quasi-experimental study of natural classrooms that employ different levels of use of ICT as part of their regular instructional program in core academic areas (mathematics, language arts, etc). A multiple-phase design is proposed, with testing and data recording taking place on three occasions over an academic year to ascertain the relationship of the various variables of interest.

The student outcome measures of interest will cover aspects of learning-to-learn abilities, attitudes and beliefs about ICT and learning, and ICT skills.

The program is in the process of developing four instruments for trialing with students in 6–8 member countries (Australia is not participating in the trialing of these instruments):

- ◆ A test of ICT concepts and skills — a multiple-choice test with sections related to terminology, (eg. What is a virus?); data structures, communication (eg. Which of the following is a complete email address for a person?); operations (eg. What happens when...?); and appropriate use.
- ◆ A performance assessment strategy based on four tasks to be complete on a computer that has spreadsheet, database, web browser and word processor functions. Each of the tasks will be of one-hour duration and a student will complete the four tasks over a week.
- ◆ A survey of student computer usage and access, to be assessed by self-report measures using a 6-point Likert scale.
- ◆ A survey of student attitudes to ICT.

National Educational Technology Standards for Students (NETS)

The National Educational Technology Standards (NETS) project is an initiative of the International Society for Technology in Education (ISTE). It was funded by the National Aeronautics and Space Administration (NASA) in consultation

with the US Department of Education; the Milken Exchange on Education Technology; and Apple Computer, Inc.

Table 2: Example of the NETS standards for a Year 8 classroom.

Foundation Standards	Performance Indicator	Classroom Example/Scenario
Technology productivity tools. Technology research tools.	Use content-specific tools, software and simulations to support learning and research.	In unit on rocks and minerals, Year 8 students explore topics using CD-ROM, store information in databases, and create HyperStudio presentations to share with the class. Students locate internet site "Ask a Geologist" and email questions about rocks and minerals to geologists sponsoring the site. The science teacher organises a local geological dig to help students begin their own rock and mineral collection.
Technology productivity tools. Technology problem solving and decision making tools.	Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration and learning throughout the curriculum.	
Technology communication tools. Technology research tools. Technology problem solving and decision making tools.	Design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom.	
Technology communication tools. Technology research tools.	Collaborate with peers, experts and others using telecommunications and collaborative tools to investigate curriculum-related problems...and to develop solutions and products for audiences inside and outside the classroom.	

The project developed standards (ISTE, 1998) to guide educational leaders in recognising and addressing "the essential conditions for effective use of technology to support PreK-12 education". The materials specify:

- ◆ 6 foundation standards relating to basic operations and concepts; social, ethical and human issues; technology productivity tools; technology communications tools; technology research tools; and technology problem-solving and decision-making tools;
- ◆ performance indicators for four stages of schooling: PreK-2; Grades 3-5; Grades 6-8; and Grades 9-12 (with outcomes aligned to one or more of the foundation standards); and
- ◆ examples and scenarios for each stage of schooling.

Each of the six foundation standards include two to three indicator statements, describing outcomes related to proficiency or understanding. For example, the foundation standard *technology communications tools* has two indicators: "students use telecommunications to collaborate, publish and interact with peers, experts and other audiences" and "students use a variety of media and formats to communicate information and ideas..."

ICT Monitoring — The Netherlands

The Netherlands has no national curriculum, but student learning results are measured against 'core-standards'. The National Institute for Curriculum Development has formulated specific standards for ICT skills and for ICT use within subjects in the secondary years.

Since 1997 the Ministry of Education in the Netherlands, through the National Inspectorate, has undertaken annual ICT monitoring of the impact and implementation of national ICT policy for schools. The purpose of the monitoring program is to assess the progress that schools are making towards the integration of ICT in their everyday teaching and learning programs. The program monitors ICT use in primary, secondary and tertiary sectors and in teacher training through a series of surveys, interviews and in-depth case studies.

The monitoring program includes:

- ◆ interviews with students and teachers about access to and use of ICT in teaching and learning;
- ◆ surveys and case studies of the use of ICT in teaching (undertaken by the national inspectorate);
- ◆ evaluation of courses on ICT skills and associated learning outcomes; and
- ◆ a survey, based on self-assessments, of ICT skills for a sample of primary and secondary students.

Besides describing the state-of-the art of the use of ICT in Dutch education, the ICT-monitor provides an insight in what factors positively or negatively influence the implementation of ICT in education. These factors are ordered in four clusters of indicators:

- ◆ preconditions — indicators external to the school, or factors which cannot easily be manipulated by the school, such as the social and economic status of the student population or the financial support offered by the government;
- ◆ adoption conditions — which relate to the decision to start using ICT in education. In most cases the school can influence these choices through, for example, the ICT-infrastructure of the schools and the attitude of teachers towards ICT;
- ◆ implementation conditions — those that are important for the actual implementation of ICT in the school, such as school policy and the development of teacher's competence; and
- ◆ implementation outcomes — the actual use of ICT for educational purposes.

A sample of students and teachers in schools and other educational institutions are surveyed each year, with a focus on:

- ◆ the use of computers in teaching and administration;

- ◆ what students are able to do on a computer (games, e-mail, word processing, etc); and
- ◆ their attitudes about using computers (interest/usefulness).

None of the instruments measure student ICT skills and knowledge, although they require students to provide self-assessments on some aspects of their use of ICT.

In 1992 and 1998 research was undertaken to augment the information available from the monitoring program. The research included testing students on their acquisition of 'functional knowledge' of ICT. Students in the last year of primary school and second year of high school were assessed as part of these research studies.

The assessment focused on 4 domains of functional knowledge:

- ◆ data-gathering and information processing;
- ◆ knowledge about the way hardware and software work;
- ◆ knowledge of various applications; and
- ◆ knowledge of the social importance of ICT.

European Computer Driving Licence (ECDL)

The ECDL is used in a number of European countries to certify skills of workforce entrants and participants against a set of criteria in relation to their ICT skills and knowledge. It was developed in Ireland, which is the country where it is used most extensively. A quarter of the secondary schools in Ireland have established test centres that can assess 15–16 year old students and provide assessment and certification services to the broader community.

The ECDL charges a fee for each 'skills card' (the basis of the Certificate) and European-wide sales indicate that approximately 40,000 certificates will be issued this year across all sectors. It is clear from this level of sales that the ECDL is not yet viewed as a universal option by European school systems, or post-school training and employment sectors.

The structure of skills and knowledge assessed in the ECDL is not specifically aligned with the curricula of European school systems.

The training and assessment is based on self-paced learning modules provided as a CD ROM covering the following seven modules of functional ICT skills:

- ◆ Basic concepts of IT;
- ◆ File management;
- ◆ Word processing;
- ◆ Spreadsheets;
- ◆ Databases/Filing Systems;

- ◆ Presentation and Drawing; and
- ◆ Information Network Services.

An international version of the ECDL is in use in a small number of independent schools and some tertiary and higher education institutions in Australia.

ICT Access and Literacy in the Tertiary Sector

The Department of Employment, Education and Training (DETYA) is conducting a research project to investigate ICT access and ICT literacy among students in universities and the VET sector. The objectives of the research project, which is still in progress, include:

- ◆ understanding and defining the concepts of ICT literacy access and ICT literacy;
- ◆ proposing cost-effective processes for measuring and assessing student ICT access and literacy; and
- ◆ putting forward options to assist government to determine relevant and viable measures to support ICT access and literacy for tertiary students.

The ICT literacy and access questionnaire will survey:

- ◆ the frequency with which students perform defined ICT tasks (such as ‘placed an image or graphic into a document’);
- ◆ the frequency with which computers are used for specific purposes (such as ‘for communication with friends and others using email’);
- ◆ where computers are used (such as at work, library, home, etc);
- ◆ how often students use ICT facilities of their educational institutions; and
- ◆ the frequency with which teachers use ICT for teaching purposes.

Advice in Relation to the Establishment of a National System for Monitoring ICT Skills and Knowledge

There are a number of international and national developments in the assessment, monitoring and research about ICT skills and knowledge that are of direct relevance to the development of a national system of monitoring in Australia.

The relevant components of these developments are as follows.

- ◆ The monitoring of ICT skills and knowledge does not have the depth of heritage to draw on that other areas of national monitoring, in particular literacy and numeracy, can draw on.
- ◆ ICT skills and knowledge are characterised by their relative ‘infancy’ compared to the ‘mature’ position of knowledge, practice and assessment of teaching and learning in the areas of literacy and numeracy.

- ◆ The relevance of specific ICT skills and knowledge is driven by a high level of technological change that results in continuous revision of what counts as both ‘basic’ and ‘advanced’ skills and knowledge in the field.
- ◆ National monitoring and assessments of ICT skills and knowledge to date have employed weak methodologies, based on self-report measures — research and monitoring experience has indicated that such methodologies may not be sufficiently valid and reliable for national monitoring purposes. There is evidence of an inverse relationship between objective measures of ICT skills and self-assessments of ICT skills in some contexts.
- ◆ The evidence from self-report methodologies suggests that students report their ICT skills to be of a higher level than teachers, although this should be treated as a tentative conclusion given the issues of validity that pertain to self-assessment measures.
- ◆ The focus of international studies — PISA 2000, the IEA SITES and CERI development work — is principally on the potential for data on ICT use in the learning environment, and the access and attitudes of students to ICT, to elucidate the factors influencing computer-based assessments of achievement in other domains (literacy, numeracy, science and other core curriculum areas), rather than cross-national assessment of achievement against agreed standards of ICT skills and knowledge.
- ◆ Information about the ICT skills and knowledge of Australian students from cross-national studies is unlikely to be available before 2005 at the earliest. There is no agreement in existence for continuing studies to provide international comparative data, although there are ongoing discussions in a number of international organisations about the possibility and desirability of developing comparative data in relation to ICT knowledge and skills.
- ◆ The research on which this report is based was unable to locate any non-Australian school system that currently has a program for monitoring ICT skills and knowledge. Various curriculum frameworks are in existence and some systems are conducting surveys of a range of aspects of ICT usage in schools. The monitoring system in the Netherlands appears to be the most comprehensively developed. It focuses on access, attitudes, usage of ICT and has commissioned research to assess ICT skills and knowledge through a self-assessment approach that is not dissimilar to that used in the Australian research in this area (Meredyth *et al.*, 1999).
- ◆ The European Computer Driving Licence (ECDL) has currency in a number of European countries and is in use in the tertiary and higher education sector. It has a toe-hold in Australia, principally in a small number of high fee-paying independent schools and a small number of Universities and TAFE Colleges. The ECDL uses a competency based training program and associated computer-based assessments that generate a certificate in ICT skills. Internationally, the system is not widely used in the school-age population. Its main area of application is in the post-school training, tertiary and higher education sectors.

SECTION 6: A FRAMEWORK FOR NATIONAL MONITORING

This section develops the framework for a national monitoring program by providing a critical analysis of the issues attendant on the developments discussed in the earlier sections. Following an analysis of the key issues, the principal schemes that have been developed nationally and internationally are analysed and classified against relevant parameters for a national monitoring system.

Definitions and Terminology

At an early stage in the development of a national monitoring framework it will be necessary to establish a common lexicon for the discussion of issues and matters related to ICT. In Tasmania, Queensland and New South Wales the word *computers* is used to refer to ICT activities and outcomes. In Queensland the term *computers in learning* is used along with *learning technology* which is 'concerned with the use of computers and related technologies in learning'. In Tasmania the term *computers as tools for teaching and learning* is used, while in NSW the phrases *computer-based technologies* (eg. hardware and software) and *computer-based capabilities* (the capabilities developed by students) are used.

What is referred to in Tasmania and NSW as computers and *computer-based technologies*, is referred to as *learning technologies* in WA, Queensland and Victoria. "The various forms of information technology which is used to improve student learning"(WA). The term *learning technologies* in the WA context includes computer-based technologies, but also includes other technologies used for learning such as whiteboards. In WA the term *information technology* refers specifically to processes, applications and equipment for handling information but has a broader application than student learning. The ACT also uses the term *information technology* to refer to a wide range of technologies (television, radio, printing), but recommends use of the term when referring specifically to computers and related learning technologies.

The variation in the use of terminology in relation to technology, technology education and information technology so concerned the Technology Education Federation of Australia (TEFA) that it sought agreement from education systems for the use of terms. They recommended that the term *information technology* in education contexts be "used to refer to computers and related learning technologies" and that the term *technology* "be reserved for use when referring to all things technology...in curriculum or out of it" (TEFA, 1998).

For the purposes of this report the term *information and communication technologies* (ICTs) has been adopted to encompass the broad range of technologies used for accessing, gathering, manipulation and presentation or communication of information. This broad definition has been adopted because it is widely accepted that the convergence of computers, telecommunication and information processing will form the nervous system of the knowledge economy of the next few decades. The term ICT is also emerging internationally as a more up-to-date way of referring to the range of technologies that are being

integrated into school environments as part of the infrastructure for learning, for example, it is now the predominant term used in the OECD publications.

The skills and knowledge that students will need to learn effectively and to be able to transfer to other environments outside the classroom requires an agreed definition of ICT knowledge and skills. Such a definition needs to be interpretable at different stages of the development of student skills and knowledge.

The NSSITS indicated that “it is difficult to define skills...in isolation from teaching–learning contexts and from the ends to which those skills might be put by the students who have acquired them” (Meredyth *et al.*, 1999: 294). The remit that shaped the NSSITS defined the relevant skills as:

- ◆ using information and computer-based technologies to locate, access, evaluate, manipulate, create, store and retrieve information;
- ◆ expressing ideas and communication with others using computer-based technologies;
- ◆ developing an awareness of the range of applications of computer-based technologies in society;
- ◆ discriminating in the choice and use of computer-based technologies;
- ◆ developing the confidence to explore, adapt and shape technological understanding and skills to challenges now and in the future. (Meredyth *et al.*, 1999; p3)

The existence of a hierarchy of ICT skills and knowledge is clearly evident from systemic curriculum documents, but there is rarely any formal delineation of the relevant levels of the hierarchy. The ICT skills and knowledge envisaged as necessary in a knowledge–based society are not simply the functional skills required to ‘operate’ technology, information and communications systems, but deeper knowledge structures and models that provide the basis for interpreting and accessing the social and economic opportunities of such a society. However, the high level of development made possible by continuing technological advances means that the relevance of particular ICT skills and knowledge is subject to continuous revision as to what counts as a functional skill.

One classification of levels that is evident from the range of national and international developments described in earlier sections of this report is the distinction between ‘functional’ skills and ‘higher–order’ knowledge about using ICT. Functional skills refer to the replicable functions that a student may perform in undertaking tasks in an ICT environment. Examples include: cutting and pasting a graphic; using a spell checker; drawing a pie chart, sending an eMail. On the other hand, higher–order ICT knowledge refers to more complex activities that a student may perform, but which require a meta–understanding of *when* and *where* to apply ICT, in addition to *how* to apply it. Examples include: formatting a document to make it more readable for a specific type of audience, representing different aspects of a relationship between two variables through the choice of appropriate graphs, and collaboratively developing a presentation

over the internet. Higher-order knowledge requires the application of a complex of functional skills, but is much more than this as it requires an understanding of when and where to utilise the complex of functional skills in achieving a specific ICT-based outcome. Such understanding incorporates meta-understandings of the mediating and tool functions of ICT. An example is the understanding that 'identity' is a necessary component of effective communication by eMail.

Hence, the essential difference between functional skills and higher-order knowledge is the level of complexity and the meta-understandings of the relationships within the activity. Higher-order knowledge is not simply the aggregation of functional skills. It incorporates functional skills into an understanding of the solving of a problem or a way of thinking about a problem or set of ideas. A program that is capable of monitoring Goals 1.1–1.6 of the National Goals for Schooling will require an assessment framework that can assess at the level of both functional skills and higher-order knowledge.

Nature of the Field of ICT Knowledge and Skills

The confluence of information technology, communications and knowledge will be a major influence on economic and social life over the next several decades. Education is viewed as a fundamental part of the infrastructure of future social and economic prosperity. The imperative for high quality ICT skills and knowledge is particularly pertinent as we move from an industrial to a knowledge-based society. The National Goals for Schooling articulate a set of outcomes that will be required by entrants to adult life in a knowledge-based society.

Unlike the other current foci of national monitoring—literacy, numeracy and science—the ICT field is still an emergent component of the curriculum. This means that a system for the monitoring of ICT skills and knowledge does not have a similar depth of heritage to draw on in terms of established understandings of the content and practices of the field.

The purpose of including ICT in the curriculum is two-fold. First, it recognises the increasingly pervasive role of ICT in all aspects of our society and the economy. Thus, young people need to develop an understanding of the role of ICT and acquire appropriate ICT skills and knowledge to critically engage as productive citizens in the emerging knowledge-society. The acquisition of ICT skills and knowledge for this purpose takes place both inside schools and out-of-schools.

Second, although the conclusiveness and comprehensiveness of research evidence remains equivocal, there is increasing evidence that ICT can be an important element in enhancing the effectiveness of school learning environments. Research indicates that ICT can enhance learning across a range of cognitive and non-cognitive outcomes for students. The effective use of ICT has been shown to impact on *cognitive* learning outcomes in the areas of:

- ◆ curriculum specific knowledge;

- ◆ ICT skills and knowledge; and
- ◆ higher-order thinking and meta-cognitive skills.

Research has also shown that effective ICT-based learning environments can have an impact on a range of *non-cognitive* learning outcomes in the areas of:

- ◆ work-place competencies, such as the capacity to work in teams;
- ◆ social behaviours, such as cooperation and social acceptance of others; and
- ◆ affective development, such as self-esteem, motivation and a sense of purpose.

The current and emerging practices, policies and programs of Australian school systems recognise both the broad-based ICT skills and knowledge that all students need to acquire and more specialist skills and knowledge that students planning ICT specific post-school vocational pathways need to acquire. The latter are addressed through both mainstream Year 11–12 programs and VET programs in schools, and by VET programs in the training and education sector. They are recognised in Goals 2.1–2.4 of the National Goals for Schooling, mainly in the form of participation in vocational programs and the development of enterprise skills.

School systems throughout Australia have either already developed a set of learning outcome statements that provide a curriculum framework for ICT skills and knowledge or agree that there is a need to develop such a framework. These frameworks have a high level of commonality in their elements, although they often use different terminology to describe the content of the elements of the framework. For example, all systems that responded to earlier drafts of this report indicated that their curriculum structures incorporate statements describing the following aspects of ICT skills and knowledge:

- ◆ use information and communication technologies for a range of purposes, eg. communication, problem solving;
- ◆ develop knowledge and skills in electronic communication, eg. word processing, publishing, internet, e-mail, multi-media, web publishing, presentation, video conferencing, telecommunications;
- ◆ develop an understanding of the role/range of computer-based technologies in society, eg. electronic banking, privacy;
- ◆ critically interpret and evaluate/discriminate computer mediated information, eg. determine bias, credibility, aesthetics;
- ◆ develop skills in information management, locate, access, evaluate, manipulate, create, store and retrieve information; and
- ◆ develop appropriate attitudes to the use and development of computer-based technologies, eg. confidence, responsibility, cooperation.

Recent research from schools with a successful track–record in integrating ICT in their learning environments has indicated that many are developing a curriculum view that places ‘thinking skills’ at the centre in the years when students are learning to learn. In this context:

- ◆ the early years (K–4) can be viewed as the period in which students acquire the basic skills and capacities (basic literacies) necessary to become independent learners;
- ◆ the middle years (Years 5–9) are a period in which students acquire the capacities to be independent learners through the acquisition of essential cognitive and meta-cognitive thinking and problem–solving skills and knowledge; and
- ◆ the senior years of schooling provide opportunities for acquiring depth and breadth in the acquisition and application of propositional knowledge.

The above conceptualisation of the stages of schooling can be linked directly to the emerging heuristic of viewing learning in relation to ICT as: learning *about* ICT, learning *with* ICT, and learning *through* ICT.

Learning *about* technology will become recognised as a key element of basic skills of learning in the early years as the penetration of ICT in Australian households increases towards a saturation point. Young children who have access to ICT before the age of seven years will have acquired considerable ICT skills and knowledge *about* ICT before they enter school and are likely to have sufficient functional skills to be able to use ICT in other areas of learning. It can be anticipated that a considerable proportion of these functional skills will be acquired at home, particularly as a range of electronic technologies (computers, television, telephone) converge in new home appliance applications.

Learning *with* ICT is becoming a feature of the middle years of schooling as school systems nationally move below the ratio of 1 computer for every 10 students. Once the concentration of computers in schools allows all classrooms to have access to three or more computers, or for students to have regular access to ‘learning centres’ with significant concentrations of computers, students will be able to use ICT to access networked resources and to integrate the use of technology into their learning practices.

A significant number of schools are also in the process of incorporating ICT to the extent that it provides opportunities for students to learn *through* ICT in the middle years. Learning *through* ICT potentially has the capacity to transform learning by reshaping teachers’ and students’ knowledge of the processes of thinking and learning. This is supported by teaching approaches that focus on ‘thinking skills’ in the context of providing students with access to greatly enhanced information resources, communication capacities and higher–order analytical tools to model and simulate alternative solutions and scenarios.

Learning *with* and *through* ICT are essential elements of many senior years programs in schools, although there continues to be a significant range of experience in this due to variation in teacher skills, access to computers and the development of some areas of the curriculum to take advantage of possibilities

for the integration of ICT. The opportunity of students to learn *through* ICT is also significantly constrained in the senior years by the dominant configuration of computers in computer laboratories and their inaccessibility for everyday classroom learning.

The Structure of ICT Skills & Knowledge

As students progress through their schooling they need to develop a capacity to apply ICT skills and knowledge commensurate with each stage of their educational development. The curriculum documents across Australian states and territories indicate that the ICT skills and knowledge required in the phase in which young people are developing the capacity to become independent learners include teacher assisted:

- ◆ use of ICT to enhance literacy and expression, eg. use of word processors to develop structure in writing and to revise documents;
- ◆ use of software to prepare presentations incorporating text, graphics and sound to 'explain' or 'demonstrate' learning to others;
- ◆ use of spreadsheets/graphing and other enhancements to mathematical thinking;
- ◆ use of information search tools to access and retrieve information from a range of electronic resources, eg. server files, CD ROM and Internet;
- ◆ use of ICT by learning teams to solve problems and undertake learning projects; and
- ◆ development of skills to use ICT to compare the products of learning among peers.

To develop these capacities, students have to be able to successfully undertake a range of functional tasks that require knowledge about transferring skills learnt in one context to a range of contexts (functional knowledge), such as:

- ◆ starting computers, peripherals, software packages and accessing networks;
- ◆ managing computer filing systems;
- ◆ locating and accessing information; and
- ◆ communicating via networks.

The application of functional skills across authentic contexts is also required in the demonstration of higher-order ICT knowledge. This is implicit in the hierarchical order of the statements of competencies embedded in current curriculum frameworks for the use of ICT in independent learning to:

- ◆ access and categorise information;
- ◆ use analytical tools and models to analyse text and numerical information;
- ◆ use software tools to integrate and synthesise information from a range of sources;

- ◆ use ICT to model and evaluate alternative designs and solutions to problems; and
- ◆ assess social and other non-technical factors that influence the analysis and solutions to problems.

These competencies are a primary focus in schools that are engaged in active integration of ICT in their learning environments. They are indicative of the core learning skills and knowledge that students will acquire through schooling, as schools become more adept at integrating ICT into their learning environments.

Another approach to understanding ICT skills and knowledge is to consider them in the context of 'literacies'. This places ICT skills and knowledge in a broader domain that links them to literacies in the areas of language and numeracy (Swan, 1999).

Skills and knowledge within this broader framework can be classified as basic skills, critical literacies and construction skills.

Basic skills are defined as the competencies that involve the simple manipulation of information and ICT technology and the common conventions for using them, such as accessing, decoding, encoding, and locating information.

Critical literacies are defined as the capacity to interpret, critique, evaluate and synthesise information from a range of sources, and apply this to solving problems and enhancing knowledge and personal understanding. They include the skills and knowledge required to make sense, analyse, evaluate, and apply ICT to authentic problems and activities.

Construction skills include competencies in the creation and use of information in developing ideas and opinions, for communicating and collaborating with others, and for enhancing problem solving and personal fulfilment. They include composing, developing, integrating and presenting information and knowledge.

These literacies are cumulative across school years, and by the completion of high school students should have acquired all of them. In the early stages of development of the capacity to be independent learners (Years 5/6) and the phase of schooling by which students are expected to have acquired that capacity (Years 9/10) they can be expected to have the following basic skills, critical literacies and construction skills (Swan, 1999).

By Year 5/6

- | | |
|---------------------|--|
| Basic skills | <ul style="list-style-type: none"> ▪ locate and make various components of technology and software operational — connect, start, prepare for use, use for rudimentary tasks ▪ describe ways of organising, searching and storing information ▪ work co-operatively using ICT ▪ use basic productivity tools ▪ apply basic ICT skills across learning contexts |
| Critical literacies | <ul style="list-style-type: none"> ▪ producing and using a range of software to create products and communicate ideas and information to others ▪ critically evaluate sources and integrity and completeness of information — distinguish between fact, opinion, and point of view |

- discuss social and moral, ethical, intellectual property issues in relation to the use of information
 - select appropriate tools to complete a variety of tasks
- Construction skills
- use computer-based writing and drawing tools to express ideas and thoughts in creating products to communicate with others
 - use ICT to support self-directed learning and extensions of own learning
 - revise, improve and update information and products
 - work collaboratively to communicate with others and create products

By Year 9/10

- Basic skills
- use simulation and exploratory environments to support learning
 - use school LANs and the Internet to research and source learning materials
 - use productivity tools to support team-based activities
 - use ICT tools to manage information
 - transfer high-level ICT skills across authentic environments
- Critical literacies
- distinguish different uses of a range of information
 - analyse and explain a range of non-text representations of information
 - synthesise information from a range of electronic and other media
 - plan and evaluate the use of different types of electronic information to meet specific needs
 - discuss the impact of ICT on society and the workplace
 - demonstrate an understanding of the design and components of ICT systems
 - use problem solving strategies to address routine hardware, communications and software problems
- Construction skills
- use ICT to create knowledge and communicate it to others
 - design, produce, evaluate and improve products
 - use collaborative networks to plan and produce products, and collaborate with peers, experts and others
 - choose appropriate formats and media for specific purposes
 - use ICT for the purpose of creative expression
 - use ICT tools to support research, analysis and decision making

During the preparation of this report the author conducted consultations and workshops based on the material above. The following Australian curriculum related framework of ICT skills and knowledge represents the outcome of this process:

- ◆ information management skills and knowledge — organisation, management, sourcing, storage and transfer of information;
- ◆ understanding social and ethical contexts of information use — ownership, ethics, intellectual property;
- ◆ creation skills — word processing, authoring, multi-media skills (including video, sound, graphics, etc);
- ◆ communication skills — connectivity, group processes;

- ◆ thinking tools — extending personal capacity to enhance one’s own knowledge and understandings through analysis, problem solving, simulation, computation, etc;
- ◆ research and information classification skills — representation, synthesis, evaluation, interrogation of information to create knowledge; and
- ◆ creative and design skills and knowledge — using the design/make/evaluate/improve cycle to create information and communication products and models.

Further work will need to be undertaken to develop this curriculum-based framework into an assessment framework by delineating the skills and knowledge that is appropriate at Years 5/6 and Years 9/10. The assessment framework should seek to establish two sets of curriculum-based standards for national assessment purposes. The set of skills and knowledge across the two points should be viewed as belonging to a continuous progression of student educational development and the assessment system will need to be constructed in such a way as to allow students to be assessed at the level most appropriate to their ICT knowledge and skills.

Changing Expectations of Skills

The rapid rate of innovation in technology has already lead to some skills that would have been considered important a decade ago being no longer relevant. For example, it is likely that the basic skill of ‘using a mouse’ will not be relevant in a decade from now. Even the ‘advanced’ skill of making a web site/home page’ as reported in the Real Time study as being achieved by 38% of students was considered only five years ago to be a skill that few students would gain during their schooling, but may well be considered a ‘basic’ skill within five years. The Real Time study reported that 44% of eight-year-old students had attained the ‘advanced’ skill of ‘creating a multi-media presentation’ and it is probable that this will be regarded also as a basic skill within 3–5 years.

Measurement

This section addresses four methodologies that can be employed to assess and monitor the ICT skills and knowledge of young people:

- ◆ self-report and self-evaluation approaches;
- ◆ teacher assessments of student’s skills and knowledge;
- ◆ psychometrically designed tests; and
- ◆ performance assessments.

Self-reporting/Self-evaluation

National programs for the monitoring and assessment of literacy and numeracy have employed well-constructed standardised tests of student skills and knowledge and national benchmarking has been undertaken on the basis of attempts to find suitable equivalent standards across the various tests used by

systems. By comparison the national data available for ICT skills and knowledge to date are of doubtful validity and cannot be viewed as having established valid benchmarks for future use. Because of their heavy reliance on self-report/self-assessment methodologies, the methodologies used to date to monitor ICT skills and knowledge have been weak, when compared to national monitoring methodologies for literacy and numeracy. The idea of asking students to self-assess whether they can 'read' a particular genre of writing or 'multiply 4-digit numbers' would not be considered in establishing national benchmarks in literacy or numeracy, respectively, but it has been the principal mode of assessment to date in regard to ICT skills and knowledge.

Research has indicated that self-report/self-assessment methodologies can be subject to fundamental challenges to their validity and reliability. Allen (2000) reported that recent ACER research in primary schools found that at Year 5 there was "little correlation between the teacher's perceptions of student ICT proficiency and student perceptions of their own proficiency" (p.11). There is a widely held belief among teachers that student's self-perceptions can exhibit an inverse relationship with actual levels of ICT skills and ICT skills.

Monitoring data available in systems that assess teacher's ICT skills and knowledge indicates that teacher's self-perceptions tend to be lowered after they have engaged in professional development aimed at enhancing their ICT skills and knowledge. This partly reflects the fact that many individuals have only the rudimentary understanding of the field and as they learn more about the nature of ICT skills and knowledge they downgrade their assessment of their own skills and knowledge. From a research perspective, self-report and self-assessment measures are self-referenced and their origin of reference changes as the individual's knowledge changes.

Compared to other educational monitoring programs they have been based on relatively small samples of students.

Teacher Assessments

A critical measurement issue is the current capacity of teachers to assess the ICT skills and knowledge of students. In schools where ICT in classrooms is yet to achieve a critical mass, many teachers themselves may not have the skills and knowledge to assess the skills and knowledge of students, even in terms of basic ICT functional skills. The assessment of advanced student skills and knowledge in the application of ICT is unlikely to be effectively undertaken by teachers who themselves do not have an understanding of the potential of ICT in student learning environments.

The monitoring program will need to ensure that teachers undergo appropriate training, or have relevant prior experience, in the use of the assessment rubrics against which to judge student performance. The rubrics can be developed from the support materials for the curriculum frameworks that many systems already have in place.

Teacher assessments can be based on an approach that utilises extant evidence that a student has previously demonstrated the skills and knowledge to do specified tasks supplemented by the provision of performance tasks that the student can undertake in cases where clear evidence of performance is not demonstrated from their current and previous work.

This approach is supported by current statewide testing programs that are the basis of the national literacy monitoring program, which incorporate elements of teacher-assessed work, and the proposed monitoring strategy for science which incorporates ‘teacher-mediated’ assessments of ‘practical tasks’ and ‘open-ended’ tasks. The direct application of this approach in the field of assessing ICT skills and knowledge is evident in the statewide assessment programs for ICT in the ACT and WA.

The assessment rubrics and the computer-based authentic assessment tasks discussed later will provide the required framework for moderating teacher judgements. A focus on moderation strategies is a common feature of the teacher-assessment approaches noted above for literacy, science and ICT. Moderation will need to feature as a key element of the training of teachers who will be involved in assessing students in the monitoring program.

Post-assessment moderation will be enhanced once the proposed computer-based authentic assessment tasks have been developed and incorporated into the monitoring program. The computer-generated data from these assessment tasks can be used for moderating the assessment of functional skills, such as sending an eMail, accessing a website, generating a graph from data, etc. However, other moderation strategies based on training and professional development will be required in relation to the assessment of knowledge about the use of ICT, such as the appropriate selection of different types of software to undertake a task, or the design and development of a ICT-based presentation to a specific audience. A relevant analogy is the national literacy monitoring program in which moderation of the assessment of functional skills of punctuation and spelling can be contrasted with moderation of higher-order interpretation and assessment of the use of genre appropriate to audience.

The monitoring of progress towards National Goals will be substantially enhanced if assessments of student ICT skills and knowledge are complemented by evaluation of the factors that need to be attended to in providing students with access to and opportunities to acquire such skills. Hence, it will be important that teacher professional development and the rollout of hardware in schools be addressed through a formative evaluation process to support national monitoring in the assessment of progress towards the attainment of the National Goals as they relate to ICT.

Testing

One of the roles of the monitoring of basic functional ICT skills will be to detect constraints in access and opportunities to acquire ICT skills and knowledge. The most important determinant of the acquisition of basic skills and knowledge in

the early years is likely to be access to computers at school and access to ICT in the home environment.

Pencil-and-paper tests of functional ICT skills lack authenticity, when compared against comparable tests of literacy and numeracy, because it is difficult to incorporate the basic medium of ICT (parallel to written text and numerical patterns in literacy and numeracy assessments) into pencil-and-paper assessments. That is, it is difficult to encapsulate key aspects of the use of ICT in an assessment task that does not require the use of ICT. The limited nature of pencil-and-paper functional basic skills tests that have been developed is evident from the following items taken from the FIT test administered as part of SITES–M1.

Which of the following is most likely a complete e-mail address for a person?

- ◆ Rex@ringonet.com.au
- ◆ MichelOblato@datacen@com
- ◆ 755.806.01.03
- ◆ http://John_Sale

What is a <browser> program?

- ◆ a program that sends out copies of World Wide web pages requested by others
- ◆ a database program
- ◆ a program for retrieving and displaying World Wide web pages
- ◆ a spread sheet editing program

Most current uses of pencil-and-paper assessment in ICT are not designed to directly assess specific skills, but to either seek information based on student self-assessments of their skills and knowledge (eg. NSSITS) or to gather information about access or attitudes to ICT (eg. PISA, SITES–M1).

Performance Testing

Performance-based assessment is probably the only approach that can successfully address the hierarchy of ICT skills and knowledge outlined earlier. Much of the assessment of ICT skills and knowledge undertaken against curriculum frameworks in a number of states incorporates assessment tasks that seek to measure student achievement through performance tasks.

Further development of performance assessment would be best served by combining authentic tasks and adaptive assessment strategies. Authentic tasks could be incorporated directly into assessments undertaken through the use of software driven simulations and performance tasks. For example, a student could be asked to carry out a particular ICT task and the software used to assess whether the task had been carried out satisfactorily. At the ‘functional’ skills level this might involve the student showing that they can open a file, change

text, and save the file. At a more advanced level a complex assessment task such as 'creating a spreadsheet to model specific data' could be set as the task.

The use of computer-based performance assessment would allow for performance tasks to be presented on the basis of the level of skills and knowledge of the student. Through appropriate adaptive assessment procedures software can establish the appropriate level at which to assess the skills and knowledge of each student.

There is potential to link performance-based assessment to the framework of competency as described in national training packages, although current Certificate levels would require substantial respecification. An assessment process of this type would have the capacity to include assessment of 'higher-order' knowledge in the application of ICT through the use of software simulation of specific problems.

Any proposal to develop a national certificate would need to evaluate the purpose and utility of the certificate to those holding it. Certificates are used to provide demarcation between individuals who have demonstrated particular competencies and those who have not. A certificate of ICT competency would decline in utility as the proportion of the cohort gaining it increased. If all students gained the certificate, it would have relatively little value in differentiating among students in terms of their ICT skills and knowledge. The changing nature of basic competencies in ICT may mean that a certificate would have currency for only a relatively short time.

A computer-based performance assessment system could potentially solve the problem of capturing data for aggregation and reporting at the system level for designated sub-groups of students. However, the responses from some systems to earlier drafts of this report indicate that such an approach would have to be phased in, because some schools are unlikely to have access for some time yet to suitable computers for such assessment.

Computer-based assessment tasks would provide an opportunity to moderate and complement teacher-based assessments based on rubrics developed from current curriculum frameworks.

Monitoring, Reporting and Publication of Performance Information

Monitoring

The purpose of monitoring is to evaluate progress towards the achievement of the relevant components of the National Goals for Schooling in relation to ICT skills and knowledge. In order to undertake this monitoring it is first necessary to establish the set of skills and knowledge that are represented by the Goals. Further, it is necessary to develop a set of curriculum standards that indicate the skills and knowledge that are expected to be achieved at appropriate stages of schooling. Attainment of these standards can then be said to represent specific learning outcomes standards.

The information about learning outcomes obtained from such a monitoring program provides a basis for assessing whether the Goals will be attained and for remedial action in cases where strategies may need to be adjusted in order to attain the Goals.

Reporting Against Criteria and Norms

The assessment of ICT skills and knowledge in Australian systems has mostly been based on criterion-referenced standards. Unlike other areas of assessment and monitoring (literacy, numeracy, in particular) there has been little focus on the development of norm referenced testing regimes. The nature of ICT skills and knowledge is such that they lend themselves to assessment by criterion-referenced strategies. This requires the development of standards or levels of skills and knowledge against which performance can be assessed and reported.

Assessment rubrics will need to provide a basis for teachers to classify the performance of each student. To enhance the accuracy of the assessments, the rubric should provide guidance about when the student has met the assessment criteria. Categories for recording assessments against the criteria should provide a basis for the teacher to record when:

- ◆ the student has exceeded the criteria in all aspects;
- ◆ met the criteria to a degree that demonstrates their competence in the task assessed;
- ◆ only partially met the criteria and the student has not demonstrated competence in fulfilling the task assessed;
- ◆ not completed the assessment task and, therefore, not demonstrated competence in the task assessed.

Reporting about Individual Student Achievement

At student level the most important function of assessment is for reporting to the student and parents on the progress of the student. Such assessment and reporting in relation to ICT skills and knowledge is already embedded in many system approaches to the assessment of ICT skills and knowledge. In many cases this takes the form of reporting against designated statements of learning outcomes in relation to ICT. Only one system has in place a process to report on specific ICT skills and knowledge through a formal process of certification.

Reporting at School Level

Recent research indicates that parents want access to more reliable and comprehensive information about the performance of schools (Cuttance and Stokes, 2000). Parent communities have been responsible for directly funding a significant proportion of the ICT infrastructure now available in schools and they are interested in having access to information that would allow them to monitor the impact of their efforts. Consideration should be given to the production of a report for each school that participates in the national monitoring program. The report should include the school's data and other relevant data on

student ICT skills and knowledge across the nation. The focus of such reporting will be of most utility if it is accompanied by diagnostic and strategic advice on how the school can improve on its current level of ICT performance.

Schools not participating formally in the monitoring program should be encouraged also to benchmark their own performance against the data from the national monitoring program.

Reporting at System and the National Level

The primary purpose of reporting at the system and national levels should be to provide information about progress in attaining the goals established in the National Goals for Schooling. The monitoring program will provide evidence about progress over time and information that can be used in benchmarking national performance against that for other nations.

The infrastructure to aggregate and report information at system and national level is currently not in place. At this stage, only one system is planning to collect assessment data on ICT skills and knowledge on the achievement of students across schools. Other systems have information at school-level but do not collect it for aggregation or reporting at system-level. Schools in the non-government sector generally do not have an established infrastructure to aggregate and report data across the sector.

The interpretation of information on ICT skills and knowledge that is aggregated at system level needs to address a range of issues, including:

- ◆ standards established to monitor progress against National Goals;
- ◆ trends in achievement over time within individual systems and their relationship to system capacity in enhancing student's acquisition of ICT skills and knowledge;
- ◆ achievement profiles for designated population sub-groups; and
- ◆ benchmarking in relation to international programs implemented to monitor the impact of ICT on learning and of ICT skills and knowledge.

Capacity Enhancement

The objective of a national system of monitoring is to assess progress towards the relevant National Goals. This involves two processes:

- ◆ assessing the actual outcomes of students, and
- ◆ understanding the factors that will influence further progress towards the attainment of the Goals.

The latter requires parallel information on improvement in the capacity of school systems to provide access to the opportunities for students to learn ICT skills and knowledge. In cross-national studies of achievement this is often referred to as 'opportunity to learn' and is a feature of current IEA and OECD international programs for monitoring learning outcomes. For example, the

PISA will assess the access that students have to opportunities to use ICT in designated areas of learning.

The emergent nature of knowledge about the impact of ICT on learning outcomes has focussed international studies (PISA, SITES) on the relationship between ICT and learning. Hence, such programs are aiming to gather information that will elucidate the impact of different configurations of ICT and teaching strategies on student learning outcomes.

The evaluation of progress in attaining the national goals will be significantly enhanced if it elucidates understandings about the effective use of ICT in schools. Such information may best be gathered from studies that are conducted independently of the program for monitoring student ICT skills and knowledge. Significant benefits would be gained, however, by developing synergies between elements of such studies and the monitoring program. For example, the development of an appropriate framework of student outcomes would be an area of synergistic benefit to both enterprises. Likewise, Australian participation in OECD and IEA cross-national studies would have the potential to produce significant benefits in understanding the factors critical to the effectiveness of ICT use in school systems.

Indicative Costs

The cost of a national monitoring program can be evaluated as fixed and variable costs. The principal fixed costs will be: development of the assessment tasks and the establishment of a national organisational framework for administration of the assessments. The variable costs will depend on the sampling strategy. For example, if the same number of students sampled is from a larger number of schools, the variable costs will rise. The principal variable costs are those associated with the production of assessment tasks, administration, marking, collation of results and reporting to schools.

On the basis of experience in the current monitoring programs and the various international studies that Australia has participated in over the recent past, an appropriate sample size would be of the order of 12,000 students spread across 400 schools nationally at either Year 5 or 6 and an equivalent number spread across 100–200 schools at either Year 9 or 10. On this basis, an indicative estimate of the cost of each cycle of the program would be of the order of \$1.5 million. The cost of developing the assessment tasks will probably be somewhat greater in the ICT area than they have been in literacy and numeracy, or the likely costs for science. There is less experience and base material to draw on in ICT than there is in the other three domains and the ICT program is likely to require a higher level of ongoing development to match the continuing high level of change in information and communications technologies in schools over the next few years. An additional development cost of up to \$1 million would be incurred in establishing the performance assessment tasks over the first two cycles of the program.

Distillation of Elements of a Design for a National Program

Table 3 presents an analysis of national and international initiatives that are directly relevant to the development of a national monitoring system. The initiatives are analysed in terms of the parameters that are considered to be central to the design of a national monitoring program:

- ◆ content, skills and knowledge;
- ◆ stage of schooling at which monitoring could take place;
- ◆ frequency of monitoring;
- ◆ methodology of assessment; and
- ◆ benchmarking and standards.

The purpose of analysing these initiatives against the parameters described above is to inform the capacity of the national monitoring program to build on current national and international developments.

t developments classified in relation to design dimensions of a national monitoring system

Content, Skills and Knowledge Framework	Stage of Schooling	Frequency of Monitoring	Assessment Methodology	Benchmarking	Potential Relevance to Monitoring Against National Goals
Categories Applications and concepts Historical and human issues Productivity skills Communication tools Research tools Problem-solving & decision tools.	Skills and knowledge specified by year and stage of schooling.	Not applicable.	Not applicable. Sampling — not applicable	Specifies benchmarks in terms of curriculum standards.	<ul style="list-style-type: none"> ▪ Provides international comparative ICT skills and knowledge framework relevant to schooling. ▪ A curriculum standards framework, not an assessment and monitoring framework.
Equal access to ICT designed to address associated with computer-ment in core curriculum	Year 9/10	Periodic international study — 2-year cycle.	Self-reporting and self-assessment for a sample of students.	Not intended as a benchmarking tool.	Will provide international comparative data on student attitudes and access to ICT from 2001.
Computers in schools ICT concepts and skills Attitudes to ICT Practical uses of ICT.	Not decided: probably Years 6/7 and 9/10	International study — no set cycle.	<ul style="list-style-type: none"> ▪ Sample surveys ▪ Multiple choice tests ▪ Self reporting & self-assessment ▪ Performance assessment tasks — one hour per task. 	Not intended as a benchmarking tool, but will provide evidence of international variation.	<ul style="list-style-type: none"> ▪ Potential relevance depends on future decisions and developments — may provide comparative international data on student ICT skills and knowledge. ▪ Major focus is impact of ICT on learning in core curriculum areas. ▪ Previous test of basic skills too functionally based to provide useful monitoring data.
Level of functional ICT skills Concepts of IT Management Processing Tools Word Processing/Filing Systems Animation and Drawing Internet on Network Services	Not related to stage of schooling, most use is in post-school sector.	Individuals seek certification when needed.	Computer/CDROM based assessments of all applicants who present for certification.	Not a benchmarking tool — primary function is certification.	<ul style="list-style-type: none"> ▪ Not used for national assessment in schools in any country. ▪ c40,000 certificates issued per year in EC. ▪ Not aligned to school curricula. ▪ Used by some independent schools and tertiary institutions in Australia. ▪ Focuses on ICT functional skills.

d)

<p>Monitoring program: Use of ICT Access, attitudes and self-assessed</p> <p>Program: Design and – processing; About the way hardware and Work; Use of various applications; and of social importance of ICT.</p>	<p>Primary and secondary schools, tertiary education and teacher training.</p>	<ul style="list-style-type: none"> ▪ Annual monitoring program. ▪ Research studies undertaken in 1992 & 1998. 	<ul style="list-style-type: none"> ▪ Surveys of national samples of students and teachers. ▪ Case studies of a sample of schools. 	<p>No benchmarking system in place — monitoring program does not focus on skills.</p>	<ul style="list-style-type: none"> ▪ Focus of monitoring program is on teacher and student use, access and attitudes. ▪ Accompanying research program includes assessment of student skills and knowledge. ▪ Provides an example of an integrated monitoring and research framework.
<p>ICT skills ICT skills ICT</p>	<p>Year 6/7 and Year 10</p>	<p>One-off study</p>	<p>Self-reporting and self-assessment of a sample of national students.</p>	<p>Provides estimate of percentages of students reporting they have acquired particular skills.</p>	<ul style="list-style-type: none"> ▪ Provides first national information about ICT skills reported by students and teachers. ▪ Self-report methodology provides basis for assessment of student attitudes and access to ICT, but is not a valid methodology for measuring actual skills and knowledge.
<p>Year 6 Key computer components. Simple information products. Different types of IT. Simple information products. Functional computer capabilities. Information problems. Year 10 Use of IT on individual's lives. & modify solutions to Information problems. Range of technologies. Find and develop solutions Individually and in a team.</p>	<p>Cumulative progression of skills K–10. Specific assessments at 4 stages K–10</p>	<ul style="list-style-type: none"> ▪ No systemic data reported at present. ▪ Annual assessments of students in schools. 	<p>Criterion-based teacher judgements.</p>	<p>Individual student and school profiles compared to statewide benchmark.</p>	<ul style="list-style-type: none"> ▪ Provides basis for teacher-based assessments within an Australian curriculum context. ▪ No statewide collection of data undertaken. ▪ Specified as a component of the Technology KLA. ▪ Requires teachers to make assessment on the basis of information from continuous observation of student output over an extended period.

d)

<p>der development in the context <i>omes and Standards</i> The proposed focus is: gy processes on gy skills</p>	<p>Curriculum has 4 stages K–10. Assessment at Years 7 and 10.</p>	<ul style="list-style-type: none"> ▪ To be determined — probably for a sample of students at 3–5 year intervals. ▪ Annual assessments of students in schools. 	<ul style="list-style-type: none"> ▪ Criterion assessments — external assessors. ▪ Students respond to specific authentic assessment tasks. 	<p>Sufficient numbers of students sampled to provide statewide benchmarks for comparison over time.</p>	<ul style="list-style-type: none"> ▪ Each assessment task takes a student up to 200 minutes to complete. ▪ Authentic nature of assessment tasks is true test of application of ICT skills and knowledge. ▪ Assesses understanding of how, when and why to apply specific ICT skills and knowledge. ▪ Assessment process is in early stage of field-testing.
<p>cies: g information processes and ication and collaboration and tools. ional processes and tools. g processes and tools. ion and visual display processes</p>	<p>Year 10</p>	<p>Annual assessment of all Year 10 cohort.</p>	<p>Teacher assessments of each competency against specified criteria.</p>	<p>Appropriateness is indicated by the proportion of students achieving certification each year.</p>	<ul style="list-style-type: none"> ▪ Successful students issued with a Certificate. ▪ Assessment is competencies based.

Content, Skills and Knowledge

The international studies to date have been weak in their development of a framework for assessing ICT skills and knowledge. Few of the international studies to date have assessed skills and knowledge and none have assessed the capacity for a student to transfer their functional knowledge to other contexts to the degree that is evident in curriculum-based developments. The functional skills that were assessed in the only international study that attempted to assess student ICT skills and knowledge were at such a basic level that they are irrelevant to the development of a national monitoring program. However, there is interest within the project teams for international studies under the aegis of the OECD and IEA in the development of a more appropriate set of instruments and strategies for assessing ICT skills and knowledge in future studies. These future developments are potentially of significant interest in the context of comparative cross-national assessments of student skills and knowledge.

The focus of international studies has been principally on the potential impact of ICT use in the learning environment, and access and attitudes of students to ICT. Data on ICT usage has been gathered in international studies to elucidate factors that influence achievement in other domains (literacy, numeracy, science and other core curriculum areas), rather than for cross-national assessment of student achievement against specific ICT skills and knowledge.

The developments that are nationally based are generally embedded in specific curriculum frameworks. Because of this, national developments focus on competencies and higher-order applications of ICT skills and knowledge that treat functional skills as embedded in authentic problem solving and applications in the learning environment. The Goal statements 1.1–1.6 of the National goals require a national monitoring program that builds on approaches to assessing skills and knowledge that are embedded in higher-order ICT competencies in the context of Australian curricula.

Monitoring and Stages of Schooling

In most systems ICT skills and knowledge are viewed as a continuous program of development K–12. Most national curriculum documents, both in Australia and in other nations, provide an elaborated framework of skills and knowledge for this purpose. International developments that have a specific focus on particular stages of schooling and post-school education and training have specified criteria relevant to those stages.

The national monitoring program will need to specify standards appropriate to the stages of schooling at which students will be assessed. This however, need not limit the use of the standards to a prescribed level. There is no reason why a system could not utilise each of the instruments developed at other year-levels. Ideally, the level of skills and knowledge at which individual students are assessed will be those that are most appropriate to the stage of the student's acquisition of such skills.

The National Goals are not specific about the stages of schooling at which they expect students to have acquired ICT skills and knowledge at different levels. There is no strong *a priori* rationale why the monitoring program should not focus on the same stages of schooling as those that are the focus of monitoring progress against the National Goals for outcomes in the domains of literacy and numeracy. However, the load on schools and teachers could be moderated by shifting the assessment of ICT skills and knowledge to Years 6 and 10 — that is, to the early and later stages of students acquiring the capacity to engage in independent learning.

Frequency of Monitoring

The international studies either have a 2-year cycle or have not yet reached the stage of maturity in their development where they have specified the period of their assessment cycle.

Australian school systems have developed or are in the process of developing a framework of annual and continuous assessment of ICT skills and knowledge at school-level. No Australian system as yet has developed a periodic system of assessment and reporting at system-level.

The program developed in the Netherlands is based on an annual cycle of assessment and national reporting for access and attitudes and a research program that assessed skills and knowledge in 1992 and 1998.

Given the rapid rate of advancement in this field at present, a biannual cycle of monitoring may be appropriate initially, with consideration given to a tri-ennial cycle once the program is fully functional.

Methodology of Assessment

The international developments have hitherto employed self-reporting when addressing aspects of student access to ICT, self-assessment when measuring attitudes and ICT skills and knowledge. The international studies have focussed on measuring access and attitudes to ICT, with only rare attempts to undertake assessments of ICT skills and knowledge — which have focussed on pencil-and-paper assessments of low-level functional skills. The international programs are developing performance-based measures of higher-order skills and knowledge for trialing in future studies.

The monitoring program in the Netherlands measures access and attitudes to ICT and undertakes cases studies of the implementation of ICT. The national inspectorate undertakes these and the occasional assessments of skills and knowledge is contracted to a research institution.

Of the two systems that certify ICT skills and knowledge, the ECDL certificate is not based on school curricula. The ECDL uses a computer-based assessment process. On the other hand, the ACT certificate uses a curriculum and performance-based teacher assessment process.

Assessment methodologies in Australian school systems have focussed on either teacher-based continuous assessment or performance-based assessment strategies. The most recent developments have sought to assess students on the basis of their performance in authentic assessment tasks designed specifically for such purposes.

The WA assessment tasks are expected to take students up to 200 minutes of class time to complete and the SITES M3 assessments are designed on the basis that they will each take a student up to 60 minutes to complete. The performance assessment tasks that are developed for the national monitoring program need to pay particular cognisance to the time that will be available for assessing individual students. A system of rotation of tasks among students in the sample would reduce the load on individual student assessments — not all students need to be assessed on all elements of the instrument. If such a strategy is employed, it needs to be taken into account in the design for selecting students to be assessed.

Another strategy that would allow some flexibility in the gathering of the assessment data would be to distribute the assessment tasks and allow a short period of one term for their completion. Teachers could then incorporate the tasks into their teaching program, undertake the assessments for a designated sample of students and return the data to a central collection point.

A third strategy that could be employed to reduce the potential assessment load would be to develop a series of assessment ‘probes’ in the form of performance task modules that a teacher could use to gather information on a student’s skills and knowledge in those areas where they did not have sufficient knowledge to make a judgement against the specified assessment criteria. Teachers would be encouraged to draw upon their knowledge and evidence of what individual students have demonstrated they can do and seek additional evidence in those areas where there is insufficient evidence to make a judgement about a student’s attainment of a specific skill or area of knowledge.

An assessment instrument to achieve this would need to consist of two parts: (1) a specification of the individual skills and knowledge that were to be assessed; and (2) an assessment rubric for the teacher to use in making judgements against the specified criteria.

The gains from having a single system with strong alignment between reporting to parents and national monitoring supports a design that ensures assessment of all students is undertaken at specific stages of their schooling. School systems have, however, expressed a preference for sample as opposed to population monitoring.

School-based assessment systems currently in place assess the whole cohort of students and systemic monitoring systems mostly assessing only a representative sample of the relevant cohort of students.

An appropriate sampling strategy, with allowance for individual systems to over-sample sub-populations of the full population to be assessed, will need to be developed for the national monitoring program. The sample will need to be of

sufficient size to provide confidence about the interpretation of any differences that are reported between respective sub-groups, systems, and states and territories.

Benchmarking and Standards

There is no national or international established data against which skills and knowledge for students in Years 5/6 and Years 9/10 can be calibrated for benchmarking purposes. The development of a national program for monitoring ICT skills and knowledge in Australia will be at the leading-edge of developments internationally.

A number of international studies will provide valuable data about the level of ICT skills and knowledge of students over the next five years. If Australia participates in these studies it will be in a position to undertake a comparative evaluation of the level of ICT skills and knowledge between Australian students and those in other nations.

It will be necessary to establish appropriate curriculum standards—that is a specified set of ICT skills and knowledge—to develop a framework for assessing such skills and knowledge. A defacto benchmark will then arise as a result of monitoring against these standards if there is reporting at State, territory and sector level.

At the student-level, school-level and system-level it would be possible to develop a profile of student ICT skills and knowledge in terms of the principal domains of the standards that will be specified in the national monitoring program.

Advice in Relation to the Establishment of a National System for Monitoring ICT Skills and Knowledge

A national monitoring program should seek to build on national and international developments in the areas of: content, skills and knowledge; stages and frequency of monitoring; methodology of assessment; benchmarking and standards; and monitoring and reporting.

Content, Skills and Knowledge

- ◆ Develop an appropriate definition of ICT skills and knowledge.
- ◆ Measure ICT skills and knowledge in the domains of both functional skills and higher-order knowledge.
- ◆ Monitor aspects of access and student attitudes or disposition towards ICT.
- ◆ Explicitly develop the content domain of national monitoring from school-based curriculum frameworks.

Stages and Frequency of Monitoring

- ◆ Link assessment to stages of student's educational development.

- ◆ Use a short cycle to take account of the rapid rate of change in ICT in schools.

Methodology of Assessment

- ◆ Evaluate the impact of ICT on both cognitive and non-cognitive learning outcomes.
- ◆ Use self-reporting for measuring access to ICT.
- ◆ Use self-assessment for measuring attitudes to ICT.
- ◆ Use teacher-based performance assessment to measure ICT skills and knowledge.
- ◆ Draw on research knowledge in developing assessment instruments and undertaking the monitoring program.

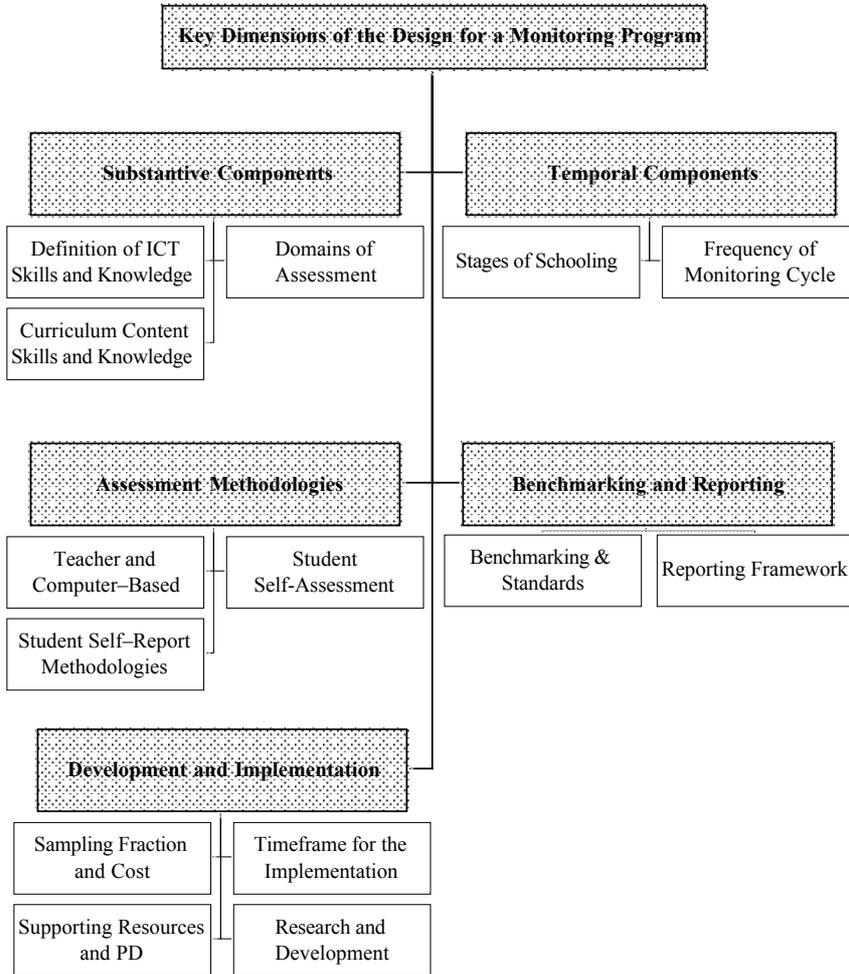
Benchmarking and Standards

- ◆ Develop standards for ICT skills and knowledge in Years 5/6 and 9/10.
- ◆ Benchmark the attainment levels of Australian students against international comparative data.
- ◆ Encourage schools to assess and benchmark their performance against the profile of performance from national monitoring.

Monitoring and Reporting

- ◆ Primary purpose is to monitor progress towards the attainment of the National Goals.
- ◆ Take remedial action where necessary to maintain progress towards the attainment of the National Goals.
- ◆ Encourage schools to report to parents against the national monitoring standards.

SECTION 7: DESIGN OF A NATIONAL PROGRAM



Based on the foregoing analysis of current programs and of national and international developments, a number of principal dimensions of the design for a national monitoring program will need to be addressed as indicated by the above figure. This section makes recommendations in each of these dimensions of a national monitoring program.

SUBSTANTIVE COMPONENTS

Definition of ICT Skills and Knowledge

The term *information and communication technologies* (ICTs) is emerging internationally as the preferred way of referring to the range of technologies that are being integrated into school environments as part of the infrastructure for learning. The term encapsulates earlier manifestations of the electronic technologies that relate to learning, such as ‘information processing’, ‘computers’ and ‘software’, and incorporates the convergence of these technologies and communications technologies that is currently taking place. This expanded definition encompasses the broad range of technologies used for accessing, gathering, manipulation and presentation or communication of information. It also captures the relevance of key policy initiatives in the areas of networks and communications (and the skills and modes of collaboration that are facilitated by such ‘connectivity’) and content development.

Recommendation 1: that the definition of information and communications technology (ICT) as “technologies used for accessing, gathering, manipulation and presentation or communication of information” be adopted for use in the national monitoring program.

Domains of Assessment

The curriculum documents across the nation indicate significant agreement about the principal elements of a national monitoring program in relation to the National Goals. Three separate domains of ICT are relevant to a national monitoring program:

- ◆ ICT knowledge and skills;
- ◆ attitudes about and confidence in the use of ICT; and
- ◆ access to ICT.

Recommendation 2: that the national monitoring program address the three domains of: ICT knowledge and skills; attitudes about and confidence in the use of ICT; and access to ICT.

Curriculum Content, Skills and Knowledge

There is considerable commonality in ICT skills and knowledge across systems in Australia. The monitoring framework should seek to develop a linked set of skills and knowledge across stages of schooling from the common curriculum elements across Australia. A number of curriculum frameworks and assessment programs (ACT, Vic, SA, WA) now contain the base information for constructing appropriate assessment rubrics (see below).

Recommendation 3: that the content domains (skills and knowledge) of the national monitoring program at both Years 5/6 and 9/10 of schooling be developed from the following framework set out earlier in this report:

- ◆ information management skills and knowledge — organisation, management, sourcing, storage and transfer of information;
- ◆ understanding social and ethical contexts of information use — ownership, ethics, intellectual property;
- ◆ creation skills — word processing, authoring, multi-media skills (including video, sound, graphics, etc);
- ◆ communication skills — connectivity, group processes;
- ◆ thinking tools — extending personal capacity to enhance one’s own knowledge and understandings through analysis, problem solving, simulation, computation, etc;
- ◆ research and information classification skills — representation, synthesis, evaluation, interrogation of information to create knowledge; and
- ◆ creative and design skills and knowledge — using a design/make/evaluate /improve cycle to create information and communication products and models.

Recommendation 4: that assessment rubrics be developed for teachers to assess the components of ICT skills and knowledge across the content domains set out above.

Information about attitudes and confidence in the use of ICT for 15 year-old students is gathered as part of the tri-ennial PISA surveys. The PISA data will provide a sufficient basis for monitoring against the National Goals in this domain for the Year 9/10 cohort, hence there will be no need to include this domain in the assessment instruments use in the national ICT monitoring program.

Recommendation 5: that the PISA and SITES studies be used to collect data on attitudes to and levels of confidence in the use of ICT for Year 9/10 students.

The assessment of attitudes about and confidence in the use of ICT for younger students is problematic and poses significant issues of validity and reliability without recourse to more expensive interview assessment strategies. Further, there is substantial evidence that attitudes about and confidence in the use of ICT is determined principally by the assess that students have to ICT. For cost reasons, the most strategic approach is to assess access only for Year 5/6 students through the national ICT monitoring program.

Recommendation 6: that attitudes about and confidence in the use of ICT not be monitored for Year 5/6 students.

Access information for 15 year-old students is gathered as part of the PISA surveys that will be conducted on a tri-ennial cycle. Gathering of such data for the Year 9/10 cohort as part of the national ICT monitoring program would

amount to duplication. Hence, there is a need to gather information about access only for the Year 5/6 cohort through the national ICT monitoring program.

Recommendation 7: that the PISA surveys be used to monitor student access to ICT for the Year 9/10 cohort and a parallel survey for the Year 5/6 cohort be integrated into the national ICT monitoring program.

TEMPORAL COMPONENTS

Stages of Schooling

The above content domains need to be specified for each stage of schooling that is to be the focus of the monitoring program.

Recommendation 8: that the program monitor skills and knowledge as discussed earlier in this report for Year 5/6 and Year 9/10 at important points in normal educational development by which students should have acquired ICT skills and knowledge.

Frequency of Monitoring Cycle

A significant factor in determining the period of the monitoring cycle is the rate of growth in the level of acquisition of ICT skills and knowledge by students. The high level of progress in making ICT facilities available in schools means that there is expected to be a substantial rise in the proportion of students meeting standards that are to be set for assessment at Year 5 or 6 and Year 9 or 10.

Recommendation 9: that the monitoring program assess the attainment levels of students in the target population every two years, with consideration of a three-year cycle once the program is established.

ASSESSMENT METHODOLOGY

Current developments nationally and internationally are based principally on three types of assessment methodology:

- ◆ factual self-reports of access to ICT;
- ◆ self-assessment of attitudes about and confidence in the use of ICT;
- ◆ combined teacher observation, pencil-and-paper and computer-based performance assessments of ICT knowledge and skills.

The term 'self-reporting' is used in this report to refer to reporting of factual information about observable events or experiences of students. This report makes a clear distinction in the use of the terms 'self-reporting' and 'self-assessment'. The term 'self-assessment' is used below to refer to student assessments of their attitudes about and confidence in the use of ICT.

Overview

Table 4 sets out the proposed multi-faceted assessment methodology required to maximise the reliability and validity of the assessment information gathered for each of the domains of:

- ◆ ICT skills and knowledge;
- ◆ attitudes to and confidence in the use of ICT; and
- ◆ access to ICT.

Table 4: Assessment of each domain

Domain of Assessment	Assessment Methodology		
	Teacher & computer-based performance assessments	Student self-assessment	Student self-reports
ICT skills and knowledge	<ul style="list-style-type: none"> ▪ Teachers use evidence of student skills and knowledge from multiple sources. ▪ Teachers assess students against specified assessment rubrics. ▪ Pencil-and-paper assessments developed for sub-domains. ▪ Computer-based authentic performance tasks developed for each domain. 	(Not recommended — issues of reliability and validity make self-assessment of skills and knowledge inappropriate for national monitoring.)	(Not recommended — students cannot report reliably on skills they do not have and knowledge they do not know.)
Attitudes to and confidence in the use of ICT	(Not recommended — intra-personal domains are most effectively assessed through self-assessment methodologies.)	<ul style="list-style-type: none"> ▪ Year 9/10 students complete survey instrument as part of tri-ennial PISA surveys. ▪ No assessment of this domain for Year 5/6 students due to issues of reliability in measurement for younger students. 	(Not recommended — intra-personal domains are not directly observable or factual in nature, hence self-reporting methodologies are not appropriate.)
Access to ICT	(Not recommended — less efficient than self-reporting by students.)	(Not recommended — less efficient than self-reporting by students.)	<ul style="list-style-type: none"> ▪ Year 9/10 students complete survey instrument as part of tri-ennial PISA surveys. ▪ Year 5/6 students complete simple multiple-choice survey as part of monitoring program.

Teacher and Computer-Based Assessment Methodologies

The assessment strategy currently being developed by Australian school systems to assess ICT skills and knowledge is one based on students completing

specifically designed assessment tasks. These tasks are assessed against performance criteria by teachers or by external examiners. In terms of a national monitoring system, the most significant challenge is to design tasks that can be assessed within the time constraints that are likely to accompany the program of assessment. A number of strategies are available to reduce the assessment load on individual students and teachers.

Performance tasks to assess ICT skills and knowledge involve testing student's understandings of the use of computers, software and communications networks. Part of the assessment process can be pencil-and-paper based, although assessing the whole of the assessment domain in this way would place unacceptable limitations on the scope of the assessments that could be made.

A useful analogy is the assessment of young people who are examined for the purpose of issuing a vehicle driving licence. The test of knowledge can be based on pencil-and-paper assessments, although this is now universally a computer-based assessment, while the demonstration of skills is assessed through a 'performance' driving test.

The ICT monitoring program should be based on best practice in constructing assessment rubrics that provide a robust basis for assessors to classify the attainment of each student, indicating the extent to which the student meets the assessment criteria. Suggested categories of assessment are:

- ◆ the student exceeds the criteria in all aspects;
- ◆ the student meets the criteria to a degree that demonstrates their competence in the task assessed;
- ◆ the student only partially meets the criteria and has not demonstrated competence in fulfilling the task assessed;
- ◆ the student was unable to complete the assessment task and has not demonstrated competence in the task assessed.

Internationally developed programs for assessing ICT skills and knowledge are focussing on computer-based strategies. The European Computer Driving Licence requires the examinee to demonstrate their skills and knowledge in an authentic ICT environment and the US Educational Testing Service is in the process of converting its pencil-and-paper tests in a wide range of domains to computer-based tests.

Nationally, the three school systems that already undertake assessments of ICT skills and knowledge require students to demonstrate their skills in an authentic ICT environment to assess most of the test domains.

A national monitoring program will require an assessment instrument development program to evaluate which components of the assessment domain can be undertaken effectively using only a pencil-and-paper methodology or examination of extant student work and which will require the student to have access to specialist equipment, such as a computer and peripherals, a communications network, etc.

Recommendation 10: that the assessment be based on teacher-judgements of student performance against specified assessment rubrics, using evidence from a range of sources — teacher observational assessments of the student’s work, assessment of written material, and direct assessments from computer-based performance tasks.

Recommendation 11: that appropriate observation schedules, pencil-and-paper tasks and computer-based performance tasks be developed to generate the evidence required to support informed teacher judgements against the assessment rubrics.

The range of ICT skills and knowledge that will become the core of future monitoring efforts is likely to require an assessment strategy that uses computer-based assessment of authentic performance tasks undertaken as part of the normal learning program in schools.

Student Self-Assessment Methodologies

The measurement of attitudes to and confidence in the use of ICT is mostly undertaken using self-assessment methodologies. Some studies have sought also to use self-assessment methodologies to assess student ICT skills and knowledge. The national assessments undertaken by the NSSITS employed self-assessment processes to gather information from both students and teachers about their ICT skills and knowledge. Evidence from a range of research and anecdotal sources indicates that this methodology is not sufficiently robust as the principal approach to assessing ICT skills and knowledge in a national monitoring program.

The primary issue is that the validity of self-assessments is related to the relative level of knowledge or skill that the student has in relation to the task. Students who could complete a hypothetical task successfully are in a position to make an informed judgement of their relative capacity to complete the task, but those who are unable to undertake the hypothetical task are not sufficiently informed of their own capacity to be able to make a valid judgement.

Unless further research were to prove otherwise, it would be unwise to base a national monitoring system on student self-assessments of their ICT skills and knowledge. The assessments would be open to challenge to an extent that the integrity of the whole monitoring system could be impugned.

Self-assessment instruments can be adapted from current national and international studies (eg. NSSITS, PISA and SITES).

Recommendation 12: that self-assessment methodologies be used for assessing the attitudes to and confidence of students in using ICT.

Student Self-Report Methodologies

The use of surveys to gather factual information through self-reporting processes is a well-established methodology for assessing the incidence or prevalence of

behaviours and can be applied efficient to gather data on access as part of the monitoring program.

In most cases, current self-report surveys are administered by teachers in schools to designated samples of students (eg. PISA, SITES). Self-report surveys at present are pencil-and-paper based. There is little use of interview of other survey methodologies. A number of projects have already developed or are developing computer-based survey instruments and these are likely to become the standard approach over the next few years. Such approaches will be able to take advantage of efficiencies afforded by using the Internet to administer the surveys and gather the response data.

In the context of a national monitoring program, pencil-and-paper based surveys of access are likely to be the most effective mode of gathering self-report information on access in the immediate future. An Internet-based methodology can be developed and made available within three years.

Self-report methodologies can be used to gather reliable information about a range of aspects of access, for example:

- ◆ whether the student has access to a computer and the Internet at home;
- ◆ what type of software is available on the home computer if one is available;
- ◆ what type of use is made of the home computer if there is one;
- ◆ frequency and duration of student use of computers at school;
- ◆ use of communications/networks at school; and
- ◆ which areas of student learning make use of ICT at school.

Recommendation 13: that self-report methodologies be restricted to the assessment of student access to ICT.

BENCHMARKING AND STANDARDS

Benchmarking, Standards and International Comparative Data

There is no national or international established data against which the skills and knowledge students at Years 5/6 and Years 9/10 can be calibrated for benchmarking purposes.

The curriculum frameworks of a number of Australian school systems provide substantial guidance about the skills and knowledge appropriate to standards at Years 5/6 and Years 9/10.

In establishing the basis for monitoring access to and confidence in the use of ICT, the development program should give consideration in the first round of monitoring to the merits of establishing linkages between the data from the 1998 NSSITS, the 2000 PISA survey and the 2001 monitoring program.

Recommendation 14: that standards be established against the National Goals as a component of the program of work that will be required to develop and trial the assessment instruments for the national monitoring program.

International studies provide a basis for evaluating progress relative to that in other nations. Australia would gain from participation in international studies, provided appropriate links can be established between the national monitoring standards and the assessments used in international studies.

Recommendation 15: that Australia participates in international benchmarking studies of student ICT skills and knowledge over the next decade. Specifically, it is recommended that Australia acquire comparative international data from the following studies:

- ◆ the 2000 and 2003 cycles of the OECD Program for International Student Assessment of access to and attitudes about ICT — this will provide the first international comparative data for Australia to use in assessing the opportunities provided for students to acquire ICT skills and knowledge; and
- ◆ the Second Information Technology in Education Study (Module 3) to be conducted in 2004 — this will provide access to the development of various aspects of the assessment of ICT skills and knowledge and strategies for evaluating the impact of ICT on student achievement in core curriculum areas.

Reporting Framework

The primary audience for reporting from the national monitoring program is MCEETYA. In addition, accountability for projects funded from public funds requires that the reporting be public.

Schools will require access to reports for their system and for designated sub-groups of students within each system. Consideration should be given to the production of a table that cross-classifies the results by level of disadvantage and non-English speaking background. In addition, results by system should be reported for metropolitan/non-metropolitan/rural students and for students of indigenous background.

Each school participating in the monitoring program should receive a detailed report for each of its students and a consolidated report for the sample of participating students in the school. Reporting should provide a formative evaluation of areas of strength in ICT skills and knowledge and areas that would benefit from further attention in each school.

Consideration should be given to having schools report to parents through their normal channels about the results for individual students who participated in the assessment program.

Schools not selected to participate in the monitoring program should be provided with full access to the instruments, procedures and assessment rubrics

and encouraged to monitor and publish a profile of their performance against the standards. Many major assessment programs that utilise 'performance' tasks publish their assessment material as standard practice. For example, Year 12 examination papers in most systems are made freely available to all schools and students once the examination is finalised each year.

Recommendation 16: that there be public national reporting from the program through the Annual National Report on Schooling and that all participating schools receive a detailed report on the performance of their students.

DEVELOPMENT AND IMPLEMENTATION

Sampling Fraction and Cost

To be most effective in meeting the National Goals for Schooling within the planned timeframe, a national monitoring program would seek to assess all students against set standards. The most effective approach would be based on full population testing of students at the appropriate stages of their schooling and enable all schools to report to parents about the attainment of ICT skills and knowledge by their children.

The cost of administering a full population assessment program for each cohort would be of a similar order of cost per cycle as the current national literacy monitoring program (estimated to be \$3+million once development costs are factored in).

Some systems feel that a significant burden is imposed by the current and projected monitoring programs in literacy, numeracy, science and ICT and the cost of population assessment is not warranted to effectively monitor progress against the National Goals, hence, they favour sample monitoring. Appropriately designed samples would provide reliable and valid information for assessing progress against the National Goals.

The samples would need to take account of the proportion of the population in each school system and sector and membership of sub-groups known to show variation in access to and achievement in relation to ICT or other core areas of the curriculum, in particular, students designated by gender, language background, disadvantage, rurality, and Aboriginal background.

A sample of 12,000 students at either Year 5 or 6 spread over 400–500 schools and an equivalent number of students at Year 9 or 10 spread over 100–200 schools would suffice to provide reasonable monitoring data at the national level. Once established, the cost of administering each cycle of the program is estimated to be \$1.5 million. Additional development costs of up to \$1.0 million would be incurred in establishing the program over its first two cycles. The major component of this development cost would be in the development of the performance assessment tasks.

Consideration should be given to sampling a higher proportion of students in small school systems and for less numerous sub-groups of the population to provide greater confidence in the estimates of the proportion meeting the assessment criteria.

Parents of students not selected in the random sample in participating schools and parents of students in non-participating schools should be able to opt-in to the monitoring program where they consider that this would be beneficial to the development of their children.

Recommendation 17: that the program monitor a random national sample of Year 5 or 6 and Year 9 or 10 students in each cycle.

Consideration should be given to providing all schools with access to the assessment tasks and procedures so that they can utilise this as a framework to monitor their own performance against the national benchmarks to be established from the monitoring program.

Timeframe for the Implementation of a National Monitoring Program

Given that the earliest any agreement to proceed to develop a program for the monitoring of ICT skills and knowledge is likely to be the fourth quarter of 2000, the earliest that field data collection in a first cycle of assessment could be undertaken would be the fourth quarter of 2001. The fieldwork data gathering for the second cycle of the program can be scheduled to take place in Term 4, 2002.

The timelines proposed below indicate a two-stage process of development and implementation:

- ◆ Cycle 1 (2001) — this cycle will trial the design and gathering of monitoring data based on teacher judgements against specific assessment rubrics using evidence from coursework and pencil-and-paper tasks. The cycle will include monitoring based on self-reports about access to ICT, self-assessments of attitudes to and confidence in using ICT, and teacher-based assessments of skills and knowledge.
- ◆ Cycle 2 (2002) — first phase of a triennial program of monitoring that includes teacher-based assessments that are informed by computer-based authentic assessment tasks in addition to appropriate pencil-and-paper tasks and evidence from coursework.

The following schedule of activities is proposed for the development of a joint program of monitoring across both stages of schooling. A Gantt chart of the proposed timelines for the development and implementation of the program follows this listing of activities.

- ◆ Contract for development of the first cycle of the monitoring program to be let by January 20 2001.

- ◆ A National Working Party (NWP) representing systems and sectors to provide advice to the contractor on the development of assessment instruments for the first cycle by February 2001.
- ◆ Contractor to develop and undertake a validation trial of an initial set of instruments and the assessment administration procedures for the first cycle by end of July 2001.
- ◆ Sampling design and assessment administration procedures to be provided by developer to NWP for approval by the end of July 2001.
- ◆ Instruments, sampling design and assessment administration procedures that are to be deployed in the first cycle to be approved by national authorities by the end of July 2000. The first cycle to collect information on access, attitudes and teacher-based assessments of functional skills.
- ◆ Training and induction of teachers in schools for assessment and administration of the first cycle of the monitoring program to be completed by the end of October 2001.
- ◆ Administration and gathering of completed assessments for the first cycle to be undertaken in Term 4, 2001.

The proposed timeline for the development and implementation of the monitoring program is designed to ensure that the first cycle of monitoring data is collected in 2001. Five tasks are scheduled to be undertaken between January and the end of July 2001. Among these are three development tasks, which can be undertaken in parallel and should be achievable in the timeframe proposed if sufficient resources are allocated to them. The proposed timeline can be used to assess the viability of any changes that might be suggested by providers who tender a development and implementation plan for the program. For example, if a tenderer can provide clear evidence that the proposed task of training and induction of teachers scheduled for August–October can be shortened, remembering that this includes a break between terms, then the development period could be extended beyond the end of July.

- ◆ Contractor to report on the first cycle of the monitoring program by the end of January 2001.
- ◆ Design and school selection for the second cycle to be completed by the end of July 2002.
- ◆ Further instruments and computer-based assessment tasks to be developed and trialed in time for inclusion in the second cycle of the monitoring program by the end of August 2002. The second cycle to include performance-based assessments of higher-order ICT knowledge, in addition to the range of data collected in the first cycle.

Recommendation 18: that fieldwork data collection in the first cycle of the monitoring program be undertaken in Term 4, 2001.

Recommendation 19: that the fieldwork data collection in the second cycle of the monitoring program be undertaken in Term 4, 2002.

Supporting Resources and Professional Development

The monitoring program will require that participating schools be given full access to the instruments, procedures and assessment rubrics and that appropriate guidance and professional development be made available to ensure the program meets high professional standards.

Although not required for the monitoring program itself, school systems should be encouraged to provide support to schools not selected to participate in a particular cycle to ensure that they are able to utilise the national program as a framework for monitoring their own performance. Unlike the development of item pools for assessments in some other domains, it should be possible to devise authentic assessment tasks each cycle that are substantially different from those of the previous cycles. Each performance tasks will consist of a complex of tasks and assess a range of skills and knowledge, hence it should prove possible to make them unique in relation to tasks employed in previous monitoring cycles. Many schools across the nation are currently using a range of external programs to monitor and assess their performance in a number of key curriculum areas and the national monitoring program for ICT skills and knowledge will provide an important addition to these options in an area where schools do not currently have access to such programs.

Recommendation 20: that all schools be given access to the performance assessment tasks and assessment rubrics following each cycle of the program.

The monitoring program can be utilised to identify and target additional professional development that teachers will require to attain the National Goals in relation to ICT skills and knowledge. To support the national monitoring program and reporting system, teachers need to be empowered to integrate ICT into their teaching. The need to have the skills and knowledge to effectively support student acquisition of functional ICT skills and the development of higher-order knowledge through learning practices that exploit the potential of ICT enriched environments.

Recommendation 21: that the program of monitoring be utilised to assess and target the professional development of teachers in the effective integration of ICT in school learning environments.

Research and Development Required

Formative evaluation and research studies will be required to elucidate issues that become evident from the monitoring program, in particular, aspects of student ICT skills and knowledge that may need specific attention to ensure that the National Goals are attained.

On the basis of current knowledge, such evaluation and research is likely to focus on areas such as differentials in access, skills and knowledge for sub-groups of students, professional development needs of teachers to satisfactorily assess student skills and knowledge, and linkages between the use and configuration of ICT in schools and its impact on teaching and learning.

Other areas that will require researching to ensure that the monitoring program maintains its effectiveness and role in ensuring that the National Goals are attained, include:

- ◆ assessment of the likely changes in technology over the foreseeable future and their impact on the specification of the ICT skills and knowledge to be monitored; and
- ◆ the relationship between ICT use in schools and the improvement of learning outcomes.

Recommendation 22: that appropriate research and evaluation studies be commissioned from time-to-time to supplement the information available from the monitoring program.

SECTION 8: SUMMARY LIST OF RECOMMENDATIONS

SUBSTANTIVE COMPONENTS

- [1] That the definition of information and communications technology (ICT) as “technologies used for accessing, gathering, manipulation and presentation or communication of information” be adopted for use in the national monitoring program.
- [2] That the national monitoring program address the three domains of: ICT knowledge and skills; attitudes about and confidence in the use of ICT; and access to ICT.
- [3] That the content domains (skills and knowledge) of the national monitoring program at both Years 5/6 and 9/10 of schooling be developed from the following framework set out earlier in this report:
 - ◆ information management skills and knowledge — organisation, management, sourcing, storage and transfer of information;
 - ◆ understanding social and ethical contexts of information use — ownership, ethics, intellectual property;
 - ◆ creation skills — word processing, authoring, multi-media skills (including video, sound, graphics, etc);
 - ◆ communication skills — connectivity, group processes;
 - ◆ thinking tools — extending personal capacity to enhance one’s own knowledge and understandings through analysis, problem solving, simulation, computation, etc;
 - ◆ research and information classification skills — representation, synthesis, evaluation, interrogation of information to create knowledge; and
 - ◆ creative and design skills and knowledge — using a design/make/evaluate /improve cycle to create information and communication products and models.
- [4] That assessment rubrics be developed for teachers to assess the components of ICT skills and knowledge across the content domains set out above.
- [5] That the PISA and SITES studies be used to collect data on attitudes to and levels of confidence in the use of ICT for Year 9/10 students.

- [6] That attitudes about and confidence in the use of ICT not be monitored for Year 5/6 students.
- [7] That the PISA surveys be used to monitor student access to ICT for the Year 9/10 cohort and a parallel survey for the Year 5/6 cohort be integrated into the national ICT monitoring program.

TEMPORAL COMPONENTS

- [8] That the program monitor skills and knowledge as discussed earlier in this report for Year 5/6 and Year 9/10 at important points in normal educational development by which students should have acquired ICT skills and knowledge.
- [9] That the monitoring program assess the attainment levels of students in the target population every two years, with consideration of a three-year cycle once the program is established.

ASSESSMENT METHODOLOGY

- [10] That the assessment be based on teacher-judgements of student performance against specified assessment rubrics, using evidence from a range of sources — teacher observational assessments of the student's work, assessment of written material, and direct assessments from computer-based performance tasks.
- [11] That appropriate observation schedules, pencil-and-paper tasks and computer-based performance tasks be developed to generate the evidence required to support informed teacher judgements against the assessment rubrics.
- [12] That self-assessment methodologies be used for assessing the attitudes to and confidence of students in using ICT.
- [13] That self-report methodologies be restricted to the assessment of student access to ICT.

BENCHMARKING & STANDARDS

- [14] That standards be established against the National Goals as a component of the program of work that will be required to develop and trial the assessment instruments for the national monitoring program.
- [15] That Australia participates in international benchmarking studies of student ICT skills and knowledge over the next decade. Specifically, it is recommended that Australia acquire comparative international data from the following studies:
- ◆ the 2000 and 2003 cycles of the OECD Program for International Student Assessment of access to and attitudes about ICT — this will provide the first international comparative data for Australia to use in assessing the opportunities provided for students to acquire ICT skills and knowledge; and
 - ◆ the Second Information Technology in Education Study (Module 3) to be conducted in 2004 — this will provide access to the development of various aspects of the assessment of ICT skills and knowledge and strategies for evaluating the impact of ICT on student achievement in core curriculum areas.
- [16] That there be public national reporting from the program through the Annual National Report on Schooling and that all participating schools receive a detailed report on the performance of their students.

DEVELOPMENT & IMPLEMENTATION

- [17] That the program monitor a random national sample of Year 5 or 6 and Year 9 or 10 students in each cycle.
- [18] That fieldwork data collection in the first cycle of the monitoring program be undertaken in Term 4, 2001.
- [19] That the fieldwork data collection in the second cycle of the monitoring program be undertaken in Term 4, 2002.
- [20] That all schools be given access to the performance assessment tasks and assessment rubrics following each cycle of the program.

- [21] That the program of monitoring be utilised to assess and target the professional development of teachers in the effective integration of ICT in school learning environments.
- [22] That appropriate research and evaluation studies be commissioned from time-to-time to supplement the information available from the monitoring program.

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APPENDIX

APPENDIX 1: SURVEY OF EDUCATION SYSTEMS

PERFORMANCE MEASURES TO MONITOR PROGRESS IN THE INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) KNOWLEDGE AND SKILLS OF AUSTRALIAN SCHOOL STUDENTS

INFORMATION FROM EDUCATION SYSTEMS

Your responses to the following will be used to build an overview of the current state of development across Australia and will assist in shaping recommendations for the way forward.

A. MONITORING AND REPORTING PRACTICES

Please describe the systemic monitoring of ICT knowledge and skills that currently takes place or is planned for your system?

When did (will) the monitoring commence?

Please describe current/ planned developments:

- the specific skills and knowledge monitored (attach examples);
- the age groups of students monitored; and
- the strategy for monitoring (eg. population or sample survey).

Describe the data currently available from the process and how it is broken down in the reporting process — eg. by sub-group (boys/girls/NESB, etc), grade, etc.

Outline who is provided with the information and the uses made of it for reporting to parents about the standards achieved by students, and for planning of IT strategy and the analysis of PD needs and teaching improvement.

Provide information about the monitoring systems or processes/models developed elsewhere — either in Australia or overseas — that have influenced your own system developments in this area?

How is assessment of student ICT skills carried out (eg. teacher-based assessment against specific criteria, performance-based assessment, competency assessment, pencil and paper testing, computer-based assessment, adaptive assessment, etc)?

Is the monitoring based on specific criteria for ICT skills and knowledge? If so, what is the nature of the skills and knowledge framework that is used (eg. is the assessment linked to an accredited competency certificate)?

What issues have been encountered in developing a system and reporting on student ICT skills? How have they been overcome, and what issues are foreseen in the potential development of a national monitoring scheme?

What professional development issues have been identified for teachers in terms of their role in the assessment and reporting processes associated with the monitoring program?

Have you implemented a program to assess teacher competencies in assessing the ICT skills and knowledge of students.

B. ICT CURRICULUM

Provide a list of the relevant curriculum definitions used by your system in relation to ICT skills and knowledge.

Describe the linkage in your ICT program between student skills and knowledge, the professional development of teachers in relation to the assessment of students' ICT skills and knowledge, and the relevant sections of the National Goals for Schooling in the Twenty-First Century.

Does your system's curriculum provide a detailed description of the ICT skills and knowledge that students are expected to acquire at each year-level.

What curriculum issues and constraints do you consider need to be tackled in the development of a national framework for reporting on progress in student acquisition of ICT knowledge and skills in Australian schools.

Please provide copies of any draft or published documents that are relevant to the matters addressed above.

Please provide your response to the matters above by January 21, 2000, in a document formatted for MS Word and forward electronically as an eMail attachment. If unable to forward by eMail, please courier the attachment on disk.

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THANK YOU
