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# ASSESSING STUDENT TECHNOLOGY LITERACY AT A NATIONAL LEVEL

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In recent times there have been important changes in economic and social life associated with the roles of technology. The "knowledge economy" has emphasised the production, distribution and use of new knowledge as contributor to economic growth and a product of economic activity (OECD, 1996). The emergence of an "information society" has been evident in the development and widespread implementation of information and communication technologies (ICT) (European Commission, 2000). The advent of ICT has changed the environment in which students develop skills for life, the basis of many occupational requirements and the way a number of social transactions take place (Prensky, 2004). Proficiency in ICT has become important for life in modern society and the assessment of ICT literacy has become an important component of monitoring the extent to which students develop "skills and knowledge for tomorrow's world" (OECD, 2004).

## Purpose

This paper outlines the development of a tool for assessing ICT literacy among school students and uses that tool with a sample of students from Grade 6 and Grade 10 in Australian schools to validate and refine a progress map that identifies a progression of ICT literacy. ICT literacy is analogous to reading literacy in that is both an end and a means. At school young people learn to read and they read to learn. They also learn to use ICT and they use ICT to learn. This paper is concerned with assessing ICT literacy itself (although broadly conceived) rather than how ICT impacts on learning in other domains.

Student achievement in ICT Literacy can only be demonstrated with consideration of the communicative context, purpose and consequences of the medium. In order to reflect these contexts, purposes and consequences the ICT Literacy construct is described using three 'strands': working with information, creating and sharing information and using ICT responsibly. The ICT definition, detailed contents and structure are congruent with the dimensions that are usually considered as part of studies of ICT in schools: learning to use ICT (Quellmalz, Hinojosa, 2002), learning with ICT in subject domains and learning (Quellmalz, & Kozma, 2003) through ICT to use cross-curricular competencies such as information management, problem solving and collaboration (McFarlane, 2003). In addition, the ICT construct accommodates the increasing pervasiveness of ICT in the out-of-school lives of young people. It is therefore essential that the contents of the ICT Literacy assessment instrument reflect both the in-school and out-of-school participatory experiences of young people as users of ICT.

The inclusion of communication in the ICT construct is recognition of the overwhelmingly prevalent context in which students develop and demonstrate computer knowledge and skills

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(OECD, 2006). As such, ICT holds considerable promise for expanding and enriching assessment tools so that they are based on authentic tasks (Pellegrino, Chudowosky & Glaser, 2001). Having students complete authentic tasks in authentic contexts was seen as fundamental to the design of the Australian National ICT Literacy assessment instrument.

## Definition of ICT Literacy

*Assessment Framework*

For the purpose of this assessment ICT literacy is defined as "the ability of individuals to use ICT appropriately to access, manage, integrate and evaluate information, develop new understandings, and communicate with others in order to participate effectively in society" (MCEETYA, 2005). The definition draws heavily on the Framework for ICT Literacy developed by the International ICT Literacy Panel in 2003 and the OECD PISA ICT Literacy Feasibility Study (International ICT Literacy Panel, 2002) and reflects what is emerging as a global consensus (reflected in the work of the International Society in Technology in the US and similar local, national and international standard-setting bodies) with regard to a definition of technology literacy. (Kelly and Haber, 2006) While ICT can be broadly defined to include a range of tools and systems this assessment focuses primarily on the use of computers rather than other forms of ICT.

An assessment framework, based on the definition above envisages ICT literacy as comprising a set of six key processes: accessing information (identifying information requirements and knowing how to find and retrieve information); managing information (organising and storing information for retrieval and reuse); evaluating (reflecting on the processes used to design and construct ICT solutions and judgements regarding the integrity, relevance and usefulness of information); developing new understandings (creating information and knowledge by synthesising, adapting, applying, designing, inventing or authoring); communicating (exchanging information by sharing knowledge and creating information products to suit the audience, the context and the medium); and using ICT appropriately (critical, reflective and strategic ICT decisions and considering social, legal and ethical issues).

The framework acknowledges the importance of (1) knowledge and skill regarding contemporary technology and (2) fundamental understanding and aptitudes towards dealing with information and learning about new technology as cornerstones of ICT literacy. The six processes used for this assessment framework are analogous to the six NETS*S standards for student technology literacy, standards originally developed by the International Society for Technology in Education that are the basis for most US state student technology standards.

*Progress in ICT Literacy*

Any assessment is underpinned by a conception of progress in the area being assessed. This assessment of ICT literacy is based on a hierarchy of what students typically know and can do. It is articulated in a progress map described in terms of levels of increasing complexity and sophistication in using ICT.

For those familiar with rubric-based assessment programs, this progress map is similar to the types of high-level rubrics designed to turn general standards (such as ISTE NETS*S) into a specific set of teachable and measurable items that can be used as the basis of determining student levels of ICT proficiency. While each item in such a rubric or map can be taught an assessed in a variety of ways, such a progress map is critical to defining (and thus measuring) ongoing student achievement on an individual or aggregate basis.

A progress map is always a draft to be developed and refined as result of the empirical evidence. For convenience, students' skills and understandings are described in bands of proficiency. Each band describes skills and understandings that are progressively more demanding. The progress map is a generalised developmental sequence that enables information on the full range of student performance to be collected and reported. Student achievement of the different ICT Literacy processes can only be demonstrated by taking into account the communicative context, purpose and consequences of the medium. As such, the ICT Literacy progress map shown in Table 1 is based on three "strands":

- Strand A – Working with information
- Strand B – Creating and sharing information
- Strand C – Using ICT responsibly

In *Working with Information*, students progress from using key words to retrieve information from a specified source, through identifying search question terms and suitable sources, to using a range of specialised sourcing tools and seeking confirmation of the credibility of information from external sources.

In *Creating and Sharing* Information, students progress from using functions within software to edit, format, adapt and generate work for a specific purpose, through integrating and interpreting information from multiple sources with the selection and combination of software and tools, to using specialised tools to control, expand and author information, producing representations of complex phenomena.

In *Using ICT Responsibly*, students progress from understanding and using basic terminology and uses of ICT in everyday life, through recognising responsible use of ICT in particular contexts, to understanding the impact and influence of ICT over time and the social, economic and ethical issues associated with its use.

## Table 1 Information and Communication Technology Literacy Draft Progress Map

ICT literacy is the ability of individuals to use ICT appropriately to access, manage and evaluate information, develop new understandings, and communicate with others in order to participate effectively in society.

| | **Strand A:** Working with Information | **Strand B:** Creating and Sharing information | **Strand C:** Using ICT responsibly |
|---|---|---|---|
| | *This strand includes* identifying the information needed; formulating and executing a strategy to find information; making judgements about the integrity of the source and content of the information; and organising and storing information for retrieval and reuse. | *This strand includes*: adapting and authoring information; making choices about the nature of the information product; reframing and expanding existing information to develop new understandings; and collaborating and communicating with others. | *This strand includes:* understanding the capacity of ICT to impact on individuals and society, and the consequent responsibility to use and communicate information legally and ethically. |
| 6 | Uses a range of specialised sourcing tools. Seeks confirmation of the integrity of information from credible, external sources. Uses tools, procedures and protocols to secure and retrieve information. | Uses specialised tools to control, expand and author information. Produces complex products. Critiques work and applies knowledge of conventions that shape interpretations when communicating across a range of environments and contexts. | Understands the impact and influence of ICT over time, recognising the benefits, constraints and influence of social, legal, economic and ethical issues on participation in society. |
| 5 | Searches for and reviews the information needed, redefining the search to limit or expand. Judges the quality of information for credibility, accuracy, reliability and comprehensiveness. Uses appropriate file formats and procedures to store, protect, retrieve and exchange information. | Uses tools to interrogate, reframe and adapt information. Uses a range of tools to create and enhance the design, style and meaning of information products to suit the purpose and audience. | Understands the social, legal, economic and ethical consequences associated with using ICT across a range of environments and contexts. |
| 4 | Develops questions or keyword combinations and selects appropriate tools to locate information. Appraises located information for relevance, currency and usefulness. Uses tools to structure, group and reorganise information for retrieval. | Integrates and interprets information from multiple sources. Selects and combines software and tools to structure, link and present work. Communicates work for different purposes, environments and contexts. | Understands the need for laws, codes of conduct and procedures for ICT use in different contexts. Recognises the potential for misuse of ICT and that there are procedures to address this. |
| 3 | Identifies a search question, terms and suitable sources. Browses and retrieves information. Compares and contrasts information from similar sources. Organises and arranges relevant information and files. | Reorganises information from similar sources, using the main ideas. Selects software and tools to combine and transform text, images and other elements. Communicates work using different representations for particular contexts. | Recognises fair use, software restrictions and legal requirements. Identifies responsible use of ICT in particular contexts. |
| 2 | Identifies and uses keywords in a search to locate and retrieve information from various sources. Identifies and records relevant content. | Uses the functions within software to edit, format, adapt and generate work to achieve a specific purpose and when communicating with others. | Identifies codes of conduct and ergonomic practices for ICT. Understands ICT terminology and use of computers in society. |
| 1 | Uses keywords provided to retrieve information from a single, specified source. Recognises information required. Opens software and saves files. | Identifies and uses some of the basic symbols and functions of software to record ideas. | Understands and uses basic terminology and general procedures for ICT. Describes uses of ICT in everyday life. |

## Approach

The ICT literacy assessment is administered through a computer environment using sets of six networked laptop computers with all necessary software installed. Test administrators travel to each school to manage the process. In each school the assessment process involves five students in each of three sessions. In total there were 21 networks (or mini-labs) taken into schools by trained administrators. A total of 3,746 Grade 6 and 3,647 Grade 10 students completed the survey in 263 elementary and 257 secondary schools across Australia.

A challenge for any assessment of this type is one of "scalability vs. authenticity." Assessments that are easily scalable (i.e., can be given consistently to large number of test takers over a large geographic area) include paper or online surveys and – in some cases – automated skills-based assessments. While these types of assessments can provide extremely useful information, they often lack the ability to analyse complex work products or behaviours such as a student's ability to evaluate and integrate information or student interaction and collaboration. Assessment techniques that provide for analysing higher-level abilities (techniques such as rubric-scored portfolios or classroom observations) have proven to be very difficult to scale above the classroom level, due to the resources required to ensure human graders score work products, observations and other high-level output consistently.

The ICT assessment used for the Australian study solves this problem by combining multiple assessment item types within a single, consistently administered assessment. Within the ICT assessment modules, a student would be asked linear (multiple-choice) questions to assess knowledge. They would also be asked to perform specific functions within simulations of software products to assess skill with applications such as Microsoft Windows, Word and Internet Explorer. Finally, they would be asked to provide open responses (short answers) to specific questions and create work products using live applications. These work products, created under controlled, consistent conditions for every student, are evaluated using well-defined rubrics used by trained graders.

Task authenticity was included in the ICT assessment instrument in two main ways. Firstly, as noted, students completed all tasks on computer using a seamless combination of simulated and live software applications. Secondly, the tasks (items) were grouped in thematically linked modules each of which followed a linear narrative sequence. The narrative sequence in each module typically involved students collecting and appraising information before synthesising and reframing the information to suit a particular communicative purpose and given software genre. The overarching narratives across the modules covered a range of school-based and out-of-school based themes.

The assessment instrument package integrated software from four different providers on a Microsoft Windows XP platform. The two key components of the software package were developed by First Advantage Assessment Solutions (formerly SkillCheck) (Boston, MA) and SoNet Software (Melbourne, Australia). The First Advantage system provided the test management software responsible for delivering the assessment items and capturing student data. It also provided the simulation, short constructed response and multiple choice item platforms. The SoNet software enabled live software applications (such as Microsoft Word)

to be run within the global assessment environment and for the resultant student products to be saved for later grading.

The different integrated software systems are each suited to accessing different aspects of the ICT assessment construct. The conventional simulation, short constructed response and multiple choice item platforms are suited to assessing ICT knowledge and discrete skills and capturing students' analytical responses to assessment stimulus materials such as information on websites. The live software integrated in the assessment package enables students to complete a range of authentic complex ICT products.

**Assessment instrument**

The assessment includes items (such as multiple-choice and simulated software operations) that are automatically scored and items that produce constructed responses stored as text or as authentic software artefacts. The constructed response text and artefacts are marked by human assessors.

The assessment instrument consists of seven discrete thematic modules. One module, the General Skills Test, includes only simulation and multiple-choice assessment items. Six of the modules, the Hybrid Assessment Modules (HAMs), integrate conventional simulation, multiple-choice and constructed response items with live application software. All students first completed the General Skills Test and then two HAMs. One reason for conducting the assessment with a number of HAMs is to ensure that the assessment instrument accesses what is common to the ICT construct across a sufficient breadth of authentic contexts.

Figure 1 shows the the workflow from candidate registration through the assessment.

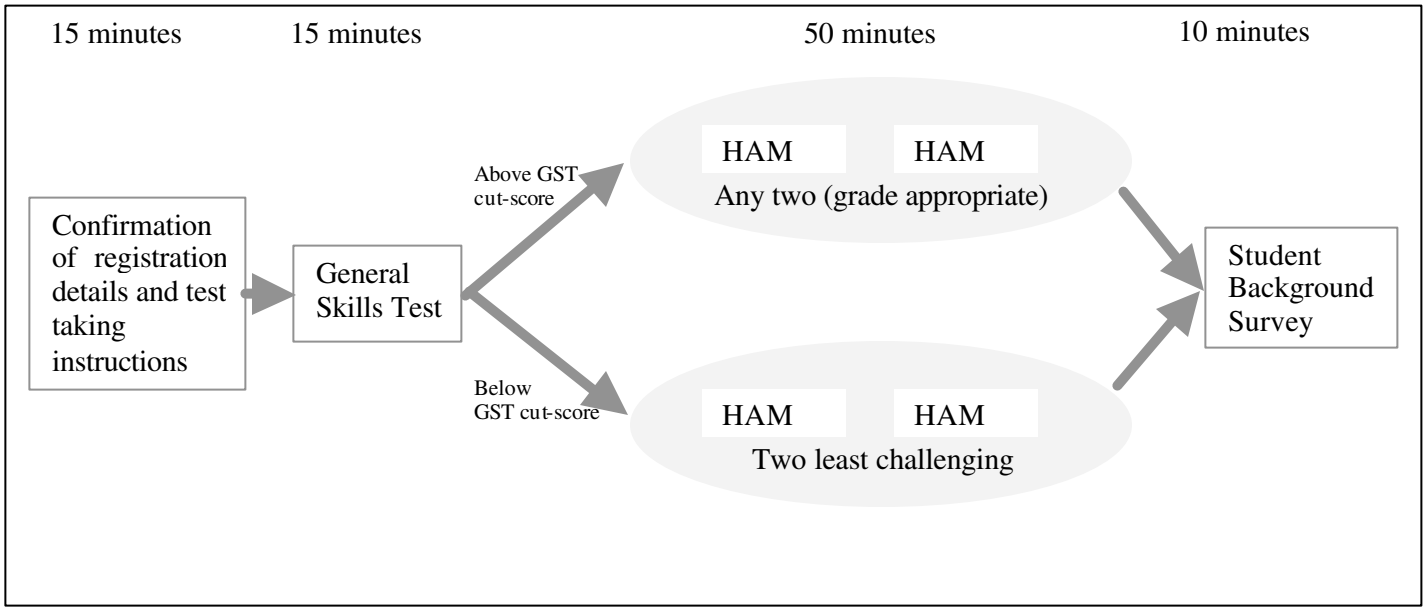

*Figure 1: Candidate workflow through the ICT assessment*

*The General Skills Test*

The General Skills Test served two main purposes in the assessment instrument. First, as all students completed the General Skills Test, data from these items could be used as universal links [anchors?? baselines?] in estimating student achievement and test item difficulty on the same scales. Second, the General Skills Test was designed to be a gatepost test of basic computer proficiency. The content of the General Skills Test was created to assess students' fundamental computer skills and knowledge and the item formats used enabled all items to be automatically scored by the system. A cut-score on the General Skills Test was established using data from a field trial conducted with 617 students from 623 schools [are these numbers right? There are more schools than students.]. Students achieving less than the cut-score were deemed to have insufficient ICT capacity to cope with the demands of the more difficult HAMs. These students were automatically allocated the two easiest HAMs.

*The Hybrid Assessment Modules*

Students who demonstrated at least basic proficiency on the General Skills Test were then randomly allocated any two Grade level appropriate HAMs. In the final survey, approximately 90 per cent of Grade 6 and 99 per cent of Grade 10 students demonstrated basic proficiency on the General Skills Test.

Each HAM has a single unifying theme. Five of the six HAMs follow a basic structure in which the simulation, multiple-choice and short-constructed response items form the lead up to a single large task using at least one live software application. Typically the lead-up tasks require students to: manage files; perform simple software functions (such as inserting pictures into files); search for information; collect and collate information; evaluate and analyse information; and perform some simple reshaping of information (such as drawing a chart to represent numerical data). The large tasks that provide the global purpose of five of the six HAMs are then completed using live software. When completing the large tasks, students typically need to select, assimilate and synthesise the information they have been working with in the lead-up tasks and reframe the information to fulfil a specified communicative purpose. The audience and software related communicative context are specified to the students as part of the communicative purpose of the large task. Students spent between 40 per cent and 50 per cent of the time allocated for the module on the large task.

The modules with the associated tasks are shown in Table 2

**Table 2 Hybrid Assessment Modules and Large Tasks**

| Module | Large task |
|---|---|
| Flag Design (Grade 6) | Students use purpose-built previously unseen flag design graphics software to create a flag. |
| Photo Album (Grade 6 & 10) | Students use unseen photo album software to create a photo album to convince their cousin to come on holiday with them. |
| DVD Day (Grade 6 & 10) | Students navigate a closed web environment to find information and complete a report template. |
| Conservation Project (Grade 6 & 10) | Students navigate a closed web environment and use information provided in a spreadsheet to complete a report to the Principal using Word. |
| Video Games and Violence (Grade 10) | Students use information provided as text and empirical data to create a PowerPoint presentation for their class. |
| Help Desk (Grade 6 & 10) | Students play the role of providing general advice on a community Help Desk and complete some formatting tasks in Word, PowerPoint and Excel. |

Four of the six HAMs are undertaken by both Grade 6 and Grade 10 students, one is undertaken by Grade 10 students only (Video Games and Violence) and one (Flag Design) is taken by Grade 6 students of all abilities and only by Grade 10 students who achieve below basic proficiency on the General Skills Test.

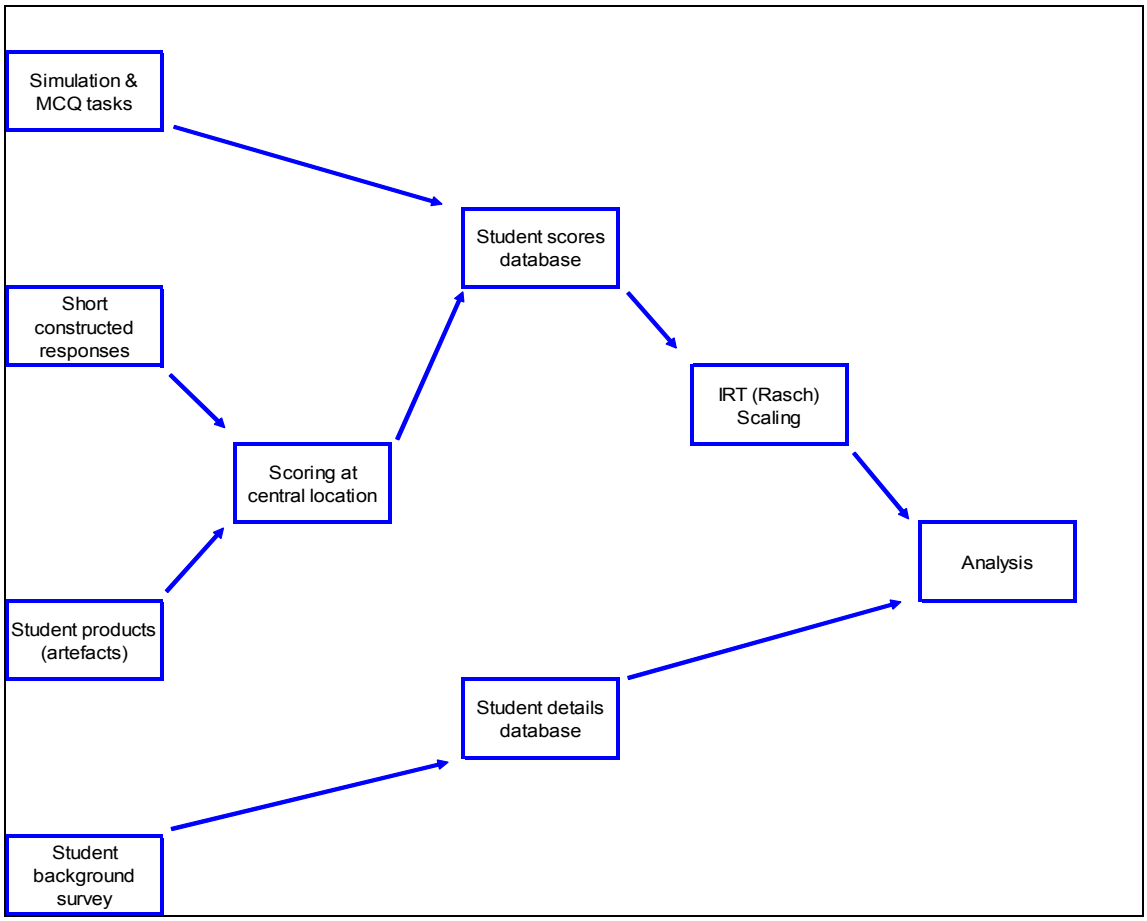


**Figure 2 Data management flowchart**

## Assessment data

The flow of operations for the assessment data is represented in Figure 2. Two main forms of assessment data are generated by students using the assessment tool. The first are those based on student responses to tasks that are either correct or not correct (including the possibility that there could several correct ways of responding to a task) or responses to multiple choice items. These are scored automatically by the system and stored directly in a student-scores database. The second are those where a student writes a short constructed response or produces an artefact that is compiled for rating by trained assessors. These responses are rated using detailed rubrics in an on-line marking system.

## Scoring

The constructed response text items and artefacts were scored by trained assessors. Each text item typically addressed one specific aspect of the ICT literacy framework. Responses to items were therefore scored according to the degree to which they demonstrated achievement of the relevant aspect. In some cases, a partial credit scoring model was used to deal with responses that were indicative of qualitatively different degrees of achievement of an aspect.

The student artefacts typically provided evidence of achievement across a range of aspects of the ICT literacy framework. The artefacts were therefore scored using a rubric of criteria relating to each of the discrete aspects of the framework. Broadly the assessment criteria for the artefacts can be classified as relating to either the substantive properties of the student work, or the students' use of the available software features. In each case the assessment criteria were couched and considered in terms of the overall communicative purpose of the artefact. A sample from a typical scoring rubric is shown in Table 3.

The on-line marking system provided for student artefacts to be displayed on a screen and ratings to be recorded in a student scores database along with the automatically generated scores. Raters worked in groups with a supervisor for each group. The preliminary evidence is that the correlation between rater and supervisor assessments was 0.86.

**Table 3 Sample Rubrics for Assessing Artefacts**

| Substance<br>E.g. PowerPoint - Text Adaptation from Resources | B. Use of technology<br>E.g. PowerPoint – Use of colour |
|---|---|
| 0 - Large sections of text copied from the resources and pasted with no editing<br>3 - Relevant sentences have been copied from resources and pasted. Some sentences have been semantically linked with student's own words.<br>5 - The key points from the resources have been rephrased and linked using student's own words or graphics to suit the purpose and audience. | 0 - No evidence of manipulation of text or background colours to support reading of the slides. Large amounts of text may be difficult or impossible to read due to poor contrast.<br>3 - Slides show evidence of careful planning regarding the use of colour. The colours chosen for the text and background are aesthetically compatible and appropriate to the task. There is sufficient contrast to enable all text and images to be seen easily and there is a clear continuity in the use of colours for specific purposes (such as headings). |

**Analysis**

Once the student scores database is assembled, analysis of responses is undertaken to establish the psychometric properties of the scales. Data were cleaned to uncover any out-of-range responses and anomalous coding. Several programs were used to analyse the data. Individual analyses were conducted of the full data set, each strand, the General Skills Test (GST) module and each module (because the modules are not intended to be of equal difficulty). The GST was given special attention because this module is common to all students and is used as a basis for assigning students to tasks. Analyses were also conducted to test for differential item functioning by sex and Grade. The analysis also tests the links between Grade 6 and Grade 10.

Our preliminary analysis indicates that we can generate highly reliable estimates of ICT ability overall and of ICT literacy for each strand.

Subsequent analysis will also involve a standards setting consultation to establish the level that is to be deemed a proficient standard. It will estimate the percentage of students achieving a proficient standard and the percentage for a range of groups within the population. This will include analysis by states (and territories), males and females, Indigenous and non-Indigenous students; language background, geographic location and socio economic status categories.

**Conclusion**

An assessment tool for ICT Literacy based on authentic tasks has been developed with sound psychometric properties. It is being used in a national assessment to estimate the percentage of students in Grade 6 and Grade 10 achieving an acceptable performance standard. The standards will attempt to capture levels of understanding and skills deemed to be "proficient". ICT literacy will be reported for all students; males and females; indigenous and non-indigenous students; students of a language background other than English and other students; geographic locations of metropolitan, provincial and remote; and socio economic status categories. The ICT Literacy assessment and its background questionnaire component will be used to analyse the relationship between computer use and experience and the actual skills of these students (in particular to which kinds of computer use lead to higher proficiency levels in this area) and the relationship between self-reported competence, and attitudes and measured ICT Literacy.

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