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Assessing ICT literacy via computer

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Abstract

ICT literacy is about using computer technology to access, manage, evaluate and create information, and communicate it appropriately. The last few years have seen dramatic changes in computer technology and how it is used, particularly by young people. Think of tablets and smart phones, "apps", cloud computing, wireless connectivity, social media, crowd-sourcing and so on. Is there a valid ICT literacy construct that remains stable and relevant despite all these changes? This paper describes a computer-based test instrument that was recently developed and used to measure ICT ability in 10 000 Australian students in Grades 6 and 10. The instrument consists of a suite of modules containing authentic simulated environments with which students interact on-line to demonstrate their ICT skills. The modules attempt to take into account the recent changes in technology. The instrument is contended to have a high degree of validity. The construction process, the contents of the modules and an IRT analysis of the response data are discussed in this paper in support of this contention.

Keywords: ICT, Assessment, Computer-based test, Validity

1. INTRODUCTION

Definition of ICT Literacy

Rapid and continuing advances in information and communication technologies (ICT) are changing the ways people share, use, develop and process information and technology (MCEETYA, 2008).

The definition of *ICT literacy* adopted for use by the Australian Curriculum, Assessment and Reporting Authority (ACARA) in their National Assessment Program (NAP) is:

> *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).*

ICT literacy is conceived as a set of six integrated key processes or core capabilities (Ainley *et al*, 2012a):

- **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 study

Commencing in 2005 and occurring every three years, a sample of Australian school students at Years 6 and 10 (aged around 11 and 15 respectively) were assessed on their ICT literacy. This assessment was commissioned by ACARA and was developed and carried out each time by the Australian Council *for* Educational Research (ACER). The present author was test development manager for the 2014 cycle of testing.

The assessment is believed to have high levels of validity since it is carefully targeted on the skills it measures and presents them in a simulated real-world environment. The test developers constructed meaningful tasks in which students use software applications that are similar to those in the real world, although scaled down and tightly controlled.

Continuing advances in hardware and software technologies have meant that the *contexts* in which ICT literacy can be demonstrated are in constant flux. User interfaces, functionality, networking capability and so forth have all changed over the past decade. The last five years in particular have seen rapid growth in the use of tablet and hand-held computers, "apps" (applications such as video editing software, to name one of thousands), data clouds, wireless connectivity, social media, crowd-sourcing of funds and online sites for the general public to buy and sell items. The set of assessment tasks described in this paper (mostly developed in 2013/2014) incorporates many of these rapidly advancing developments.

Despite the dramatic changes in technology and usage in the last few years, have the core *ICT capabilities* remained relevant? Bearing these changes in mind, this paper discusses the validity of the instruments as measures of ICT literacy in light of the characteristics of the instruments and the results of the 2014 cycle of testing.

2. METHOD

This section discusses the main steps performed in the study.

Development of the assessment modules

The assessment instrument for 2014 consisted of nine separate on-line test modules. The test delivery software controlled timing, allowing a maximum of 25 minutes per module. Each individual student was administered four modules. Each module followed a narrative designed to reflect students' typical 'real world' use of ICT. The test delivery software led students through items in lock-step fashion: once a student confirmed that an item was finished, he or she was not allowed to return to that item later. This allowed information to be used in later items that might otherwise compromise the independence of earlier items. The modules included a range of school-based and out-of-school-related themes designed to be engaging for students. In addition to short self-contained items, all the modules included multi-step 'large tasks' to be completed using purpose-built software applications embedded in the testing software.

Six modules were newly developed for use in the 2014 assessment. These modules covered skills such as working with tablet computers, using animation software and collaborating with other students. The new modules were thoroughly reviewed both within ACER and by external experts.

The remaining three modules were 'trend' modules, as used in at least one of the previous assessment cycles.

This design enabled the measurement of changes in ICT literacy ability over the four cycles of administration while at the same time (hopefully) maintaining the test construct and allowing the assessment to take account of new developments in ICT software, hardware and use.

Detailed coding guides or scoring rubrics were written for each item, so that each potential response to an item could be assigned a code in accordance with the ICT ability required to produce this response. Some items could be machine coded, while others required trained expert markers to do the coding.

To help ensure face validity and construct validity, all modules and coding guides were reviewed by stakeholders and selected ICT assessment experts from around Australia. Items were removed or modified in light of these reviews.

Trialling of the assessment modules

Before the main study was carried out, the modules were trialled in convenience sampled schools. A total of 892 Year 10 and 985 Year 6 students responded to the tasks. Student responses were coded as described above. The test developers trained and supervised the markers as part of the coding process to ensure consistent, accurate coding.

The data set was analysed using a Rasch (one-parameter) partial credit model via the ACER *ConQuest* software (Wu *et al*, 2007). Several steps were performed, some iteratively:

reviewing item characteristics (statistical/psychometric); equating link items across the two year levels; equating link items across test forms (= sets of modules); scaling trend items with new items; re-coding or deleting misfitting items; reviewing Differential Item Functioning; checking dimensionality, reliability and fit; and constructing a scale.

In reviewing the items to determine whether they fit the model and were generally suitable for use in the final instrument, the following characteristics were taken into account:

- Number of cases for this item
- Item-Rest and Item-Total Correlations
- Item fit – Weighted MNSQ
- Item Threshold(s) and Item Delta(s)
- Number of cases in each credit level, including missing data and % of total
- Point Biserial for each credit level or option
- Average Plausible Values for student ability at each credit level
- Standard Deviation for each Average Plausible Value

The Item Characteristic Curve (ICC) charts for each item were generated and inspected in turn and used in conjunction with the above item statistics in considering the behaviour and suitability of the items.

All modules and most items were deemed suitable for use in the main survey. The unsuitable items were removed from the modules. Care was taken not to interrupt the flow of the narrative in the modules.

Administration of the Main Survey

The main survey was carried out using the final versions of the modules, but using a larger sample. The sample was designed and implemented to obtain estimates of ICT literacy that were representative of the Year 6 and Year 10 populations in Australia, within states and territories and designated subgroups at the national level. Sampling procedures were designed to minimise any potential bias and to maximise the precision of estimates.

The total achieved sample for the survey consisted of 10 562 students: 5622 from Year 6 and 4940 from Year 10. These students were sampled randomly from 649 schools: 334 for Year 6 and 315 for Year 10.

Each student was administered two trend and two new modules. Year 6 students were presented with those modules deemed appropriate for their year level, while Year 10 students were able to do any of the nine modules. Apart from these constraints, the modules were randomly assigned to the students. It was observed that each item was responded to by at least 1500 students.

The analysis described in the previous section was repeated for the main survey data. The results were interpreted and discussed by psychometricians, test developers and other assessment experts.

A summary of the results is given in section 4, preceded by a description and brief discussion of the assessment tasks.

3. THE INSTRUMENT

This section outlines the task modules used in the study.

Trend modules

Three "trend" or historical link modules were included in the 2014 assessment to allow the original 2005 scale to be maintained (subject to the results of the analysis). This also enabled direct comparisons to be made between the performance of students in 2014 and that of previous test cycles. The trend modules are named Art Show (2011), Sports Picnic (2008 and 2011) and Friend's PC (2008 and 2011).

The contents of these modules have remained relevant over time, so they were deemed suitable for use in 2014; and the Field Trial was used to check whether they would scale successfully with the new modules.

Briefly, the contents of each module are as follows (with quoted descriptions taken from Ainley *et al*, 2012).

Art Show

"In the *Art Show* module, Year 10 students were given the role as manager of the part of their school's website that promotes the school's art show. They downloaded and managed images from a camera, managed communication through a webmail account and then edited and added content to the website."

As an illustration of the variety of item types in the older (trend) modules, examples of tasks that Art Show required students to perform include:

- Explain the need to delete private data from public equipment
- Add a new web page to an existing website
- Add a background image to a web page
- Upload a set of image files to a web site
- Interpret a 'link chart' to create a link from an existing web page to or from a newly created web page.
- Align images on a web page according to interface design principles
- Create a balanced web page layout
- Create a title for a web page

Figure 1 shows a screenshot from the Art Show 'large task'. Note that the *test interface* (including the yellow borders) received a minor update for the 2014 cycle; the *task interface* ("Web Maker") was left untouched so as not to interfere with item functioning.

Figure 1: Part of the Art Show 'large task' (Source: Ainley *et al*, 2012b)

Sports Picnic

"In the *Sports Picnic* module, students used a blog website and a comparative search engine to identify a venue for a sports picnic and to select sports equipment. They used tailored graphics software to produce invitations that included a map generated by using embedded mapping software."

The (simulated) graphics software was deliberately designed to be unfamiliar to students, but it used conventional *features* that ICT literati would be expected to understand.

Friend's PC

"In the *Friend's PC* module, students searched for and installed photo management software, changed settings for antivirus software, organised a photo collection and edited a photo."

As with *Sports Picnic*, the focus in *Friend's PC* was on the application of software and interface design *conventions*, rather than simple recall of how to use a known piece of software.

A few of the *other* assessment tasks that were developed in previous cycles (but not used in 2014) have been released for public viewing. These can be found in: http://www.nap.edu.au/verve/_resources/2011_ICT_Literacy_school_release_materials.pdf

Figure 2 and Figure 3 show screenshots from one of these released tasks called *Saving Electricity*.

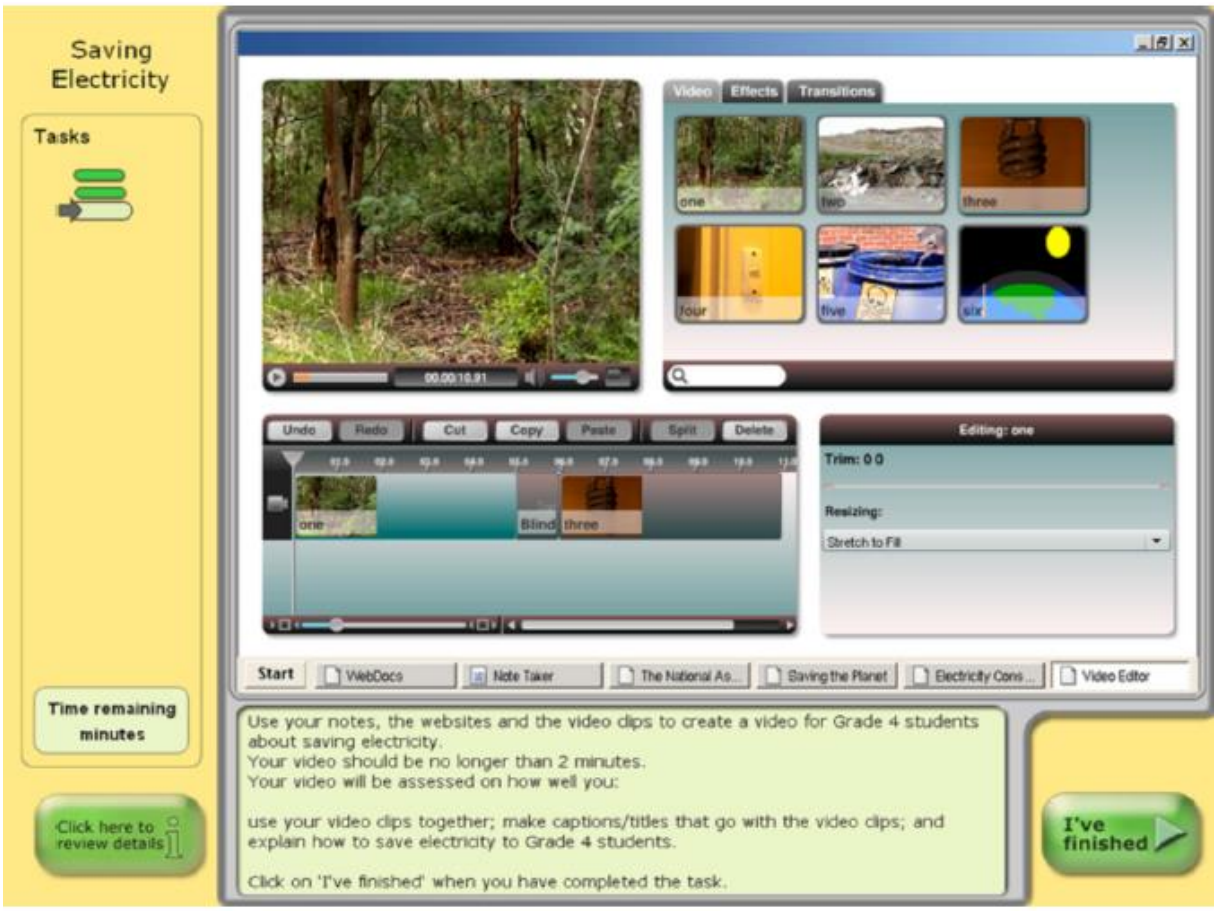

Figure 2: Part of the Saving Electricity 'large task' (Source: Ainley *et al*, 2012b)

Figure 3: An item from Saving Electricity (Source: Ainley *et al*, 2012b)

New modules

Six new modules were written for the 2014 test administration. The functionality and content of the modules reflected emerging trends in hardware and software design and usage. The second decade of the 21st century has seen the rapid rise of such things as tablet computing, social media, cloud computing, video creation and editing on hand-held devices, gaming, crowd-sourcing and, more generally, an explosion of information available on the Internet that must be searched, evaluated and digested for use. It was expected that students would be familiar with most of these developments and would find their appearance in a test quite engaging. Detailed, specific *knowledge* of the technology was **not** assumed, since the purpose of the assessment is to measure ICT literacy *skills*.

The new modules are named: Animation Video, Battle of the Bands, Computer Game, Slide Show, Techno-teaching and Technology on the Go. Briefly, the contents of each module are as follows.

- **Animation Video**: Upper primary school students need to be made aware of safety around lakes. The main task is to create an animated silent video (with captions) about water safety. The module leads test-takers through: using custom-built

software to make a video; uploading the video file to a website; and setting access properties of the video file on the website.

- **Battle of the Bands**: A student band wants to participate in a music competition, but needs to raise funds to cover travel expenses. Test-takers need to help the band. The module leads them through: completing an online registration for the competition; promoting the band using social media; and setting up on-line crowd-funding to raise money.

- **Computer Game**: A Year 10 class is to create an on-line game for Year 6 students to play. The module leads test-takers through: creating an on-line survey for the class to vote on the topic of the game; communicating with the class teacher about the survey; interpreting survey results; and finally using some software to design, implement and test the game. The game design requires the use of *computational thinking*, in particular looping and branching.

- **Slide Show**: Tasmanian Devils have been relocated to an island to escape disease. The main task is to create a slide show about the relocation program to present to a Year 3 class. The module leads test-takers through: using (a simulation of) the Internet to research the topic; creating a short slide show about the program; and writing out notes for each slide as a script to be read aloud.

- **Techno-teaching**: This module concerns the debate on whether computers can replace teachers in the classroom. Test-takers are led to write a report on this topic in collaboration with another (fictitious) student. The steps required are: searching websites to find material; producing an evaluation of this material with the aid of some 'Note Taker' software; and formatting a report that has been previously drafted by their 'collaborator'.

- **Technology on the Go**: A student takes a tablet computer on a school trip to a remote part of Australia. The module leads test-takers through: configuring the tablet to access the Internet; installing *apps* on the tablet; setting up one of the *apps* to collect weather data over a two-week period; and using software to manage and display the collected data.

4. RESULTS

The results of the analysis showed that most items fitted a one-parameter (Rasch) model very well. The trend items were included in the analysis and these scaled well with the new items; they also behaved the same way they did in previous test cycles (2008 and 2011). This supports the conclusion that the instruments continue to measure a single underlying trait – ICT literacy.

Test reliability is generally defined as the proportion of the observed test score variance that is true variance. Values range from 0 to 1 with the higher the value the more reliable the instrument. Two measures of reliability were obtained in the course of the analysis: Person separation and Expected A Posteriori / Plausible Value reliability

Person separation is an indication of how well a set of items is able to distinguish between the abilities of the people measured. WLE estimates are IRT analogues of traditional estimates of person separation reliability such as internal consistency (OECD, 2009). For the present analysis, the WLE separation reliability was 0.944, indicating a high level of reliability across the test items.

Expected A Posteriori / Plausible Value reliability (EAP/PV reliability) measures how much variance in a person's estimated ability is accounted for by the measurement model, averaged over all people tested. It is most valuable as an indicator of loss of precision due to the test design (Adams, 2005). For the present analysis, the EAP/PV reliability was 0.933 which indicates a high level of precision.

An interesting finding of the study was that the **average ability** of the two cohorts (Year 6 and Year 10) declined a small but statistically significant amount compared with the previous test cycle (2011). Since the items scaled well (including the historical links), this finding is not simply that the new items were more difficult than the old ones. It might, however, reflect a degree of complacency among educators: because most students[1] use computing devices (hand-held or otherwise), it might be assumed (erroneously) that they do not need further instruction in ICT literacy. This issue needs further investigation; the study did not collect information from teachers, schools and systems about approaches to ICT literacy education.

5. CONCLUSION

The results obtained show that the assessment instrument used in the study is reliable and valid as a measure of ICT Literacy. It has:

- **face validity** – it appears to outsiders (including stakeholders) to be measuring what it says, since it consists of meaningful tasks in which students use software applications that are like those in the real world;
- **construct validity** – it does measure what it is intended to measure and not other variables, as seen from the psychometric analysis and by the fact that a panel of experts believed that the items do measure ICT literacy; and

[1] Data collected from the study has around 90% of students reporting they have at least one tablet device at home.

- **content / sampling validity** – the nine assessment modules (using a wide range of scenarios and simulated software, containing a total of 146 items) cover the range of capabilities within ICT literacy, including accessing and managing information; evaluating the design and construction of ICT solutions and information; developing new understandings; communicating information; and using ICT appropriately.

6. REFERENCES

ACARA (2013). General capabilities in the Australian Curriculum. Retrieved from http://www.australiancurriculum.edu.au/generalcapabilities/pdf/overview

Adams, R.J. (2005). Reliability as a Measurement Design Effect. *Studies in Educational Evaluation, 31*, pp 162-172.

Ainley, J., Fraillon, J., Gebhardt, E., Schulz, W. (2012a). National assessment program: ICT literacy technical report. Sydney: Australian Curriculum, Assessment and Reporting Authority (ACARA).

Ainley, J., Fraillon, J., Gebhardt, E., Schulz, W. (2012b). National assessment program: ICT literacy Years 6 and 10 report (2011). Sydney: Australian Curriculum, Assessment and Reporting Authority (ACARA).

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) (2005). National Assessment Program Information and Communication Technology Literacy Years 6 and 10: An Assessment Domain for ICT Literacy. Carlton: Curriculum Corporation.

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) (2008). Melbourne Declaration on Educational Goals for Young Australians. Carlton: Curriculum Corporation.

OECD (2009). PISA 2009 Technical Report. http://www.oecd.org/pisa/pisaproducts/50036771.pdf

Wu, M. L., Adams, R. J., Wilson, M. R., Haldane, S.A. (2007). ACER ConQuest Version 2: Generalised item response modelling software Camberwell: Australian Council *for* Educational Research.