Information and Communication Technology (ICT) Literacy: Integration and Assessment in Higher Education

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ABSTRACT

Despite coming of age with the Internet and other technology, many college students lack the information and communication technology (ICT) literacy skills—locating, evaluating, and communicating information—necessary to navigate and use the overabundance of information available today. This paper presents a study of the validity of a simulations-based assessment of ICT literacy skills. Our overall goals for the assessment are to support ICT literacy instructional initiatives at colleges and universities.

Keywords: Higher Education, ICT Literacy, Information Literacy, Instructional Initiatives, Psychometrics, Validity

INTRODUCTION

Discussions of Information Technology in Education typically emphasize the Technology rather than the Information. Widespread technology has meant that people encounter more information, in a greater variety of formats, than ever before. Technology is the portal through which we interact with information, but people's ability to handle information—to solve problems and think critically about information—tells us more about their future success than their knowledge of specific hardware or software. These skills—known as Information and Communications Technology (ICT) Literacy—comprise a 21st century form of literacy, in which researching and communicating information via digital environments are as important as reading and writing were in earlier centuries.

ICT literate students master content faster, are better problem-solvers, become more self-directed, and assume greater control over learning [1]. Beyond the classroom, ICT literacy is essential for being productive citizens in a knowledge-driven society [16], and employers want their employees to have these skills [6]. As a result, college and university administrators are beginning to require them as competencies for graduation. This focus has led to campus-wide initiatives (e.g., [3], [15]) to improve students' ICT literacy.

However, there are several challenges to designing and implementing effective ICT literacy instruction. First, students in higher education often believe themselves to be competent users of information resources because of their daily interactions with the Internet [13]. This can lead to disinterest in learning skills to improve their use of search engines and electronic research databases. Second, the ease of transferring between social and academic environments, using the same technology, can cause disruptions in classroom activity. For example, anecdotal evidence suggests that students receiving ICT literacy instruction in a computer lab frequently disengage and go off-task by reading their email and instant messaging their friends, playing games, or searching something of interest to them. These behaviors indicate that current instruction strategies are inefficient in meeting students' perceived needs and equally lacking in an engaging delivery method. Finally, without effective assessment it is difficult to know if instructional programs are paying off – are students' ICT literacy skills improving? Educators who accept the challenge of teaching ICT literacy skills must be prepared to:

- Find a strategy to reach the user who believes she is already proficient
- Make the learning relevant to the user's needs, including using the technologies the student already knows, to anchor the learning in something familiar
- Create active learning opportunities to keep the students on task
- Assess the impact of instruction on student-learning outcomes

This paper describes the ICT Literacy Assessment, developed by Educational Testing Service (ETS), an Internet-based assessment of ICT literacy skills. The assessment was designed to support instructional efforts in ICT literacy by providing data on students' skills that can help inform decisions for instituting and evaluating information literacy programs.

ETS ICT LITERACY ASSESSMENT

In January 2001, ETS convened an International ICT Literacy Panel to study the growing importance of existing and emerging information and communication technologies and their relationship to literacy. The members agreed that little was being done to address critical ICT literacy skills in higher education [7]. In response, a consortium of experts in ICT literacy assembled to advise ETS test developers as in the design of an Internet-delivered assessment that measures students' abilities to research, organize, and communicate information using technology [9].

The assessment focuses on the cognitive problem solving and critical thinking skills associated with using technology to handle information. As such, scoring algorithms target cognitive decision-making, rather than technical competencies [8]. The assessment measures ICT literacy through seven performance areas, which represent important problem-solving and critical thinking aspects of ICT literacy skill (Table 1).

Table 1: Components of ICT literacy (from [5])

Proficiency	**Definition**
Define	Using digital tools to identify and represent an information need
Access	Collecting and/or retrieving information in digital environments
Manage	Using digital tools to apply an existing organizational or classification scheme for information
Integrate	Interpreting and representing information, such as by using digital tools to synthesize, summarize, compare, and contrast information from multiple sources
Evaluate	Judging the degree to which digital information satisfies the needs of an information problem, including determining authority, bias, and timeliness of materials
Create	Adapting, applying, designing, or constructing information in digital environments
Communicate	Disseminating information relevant to a particular audience in an effective digital format

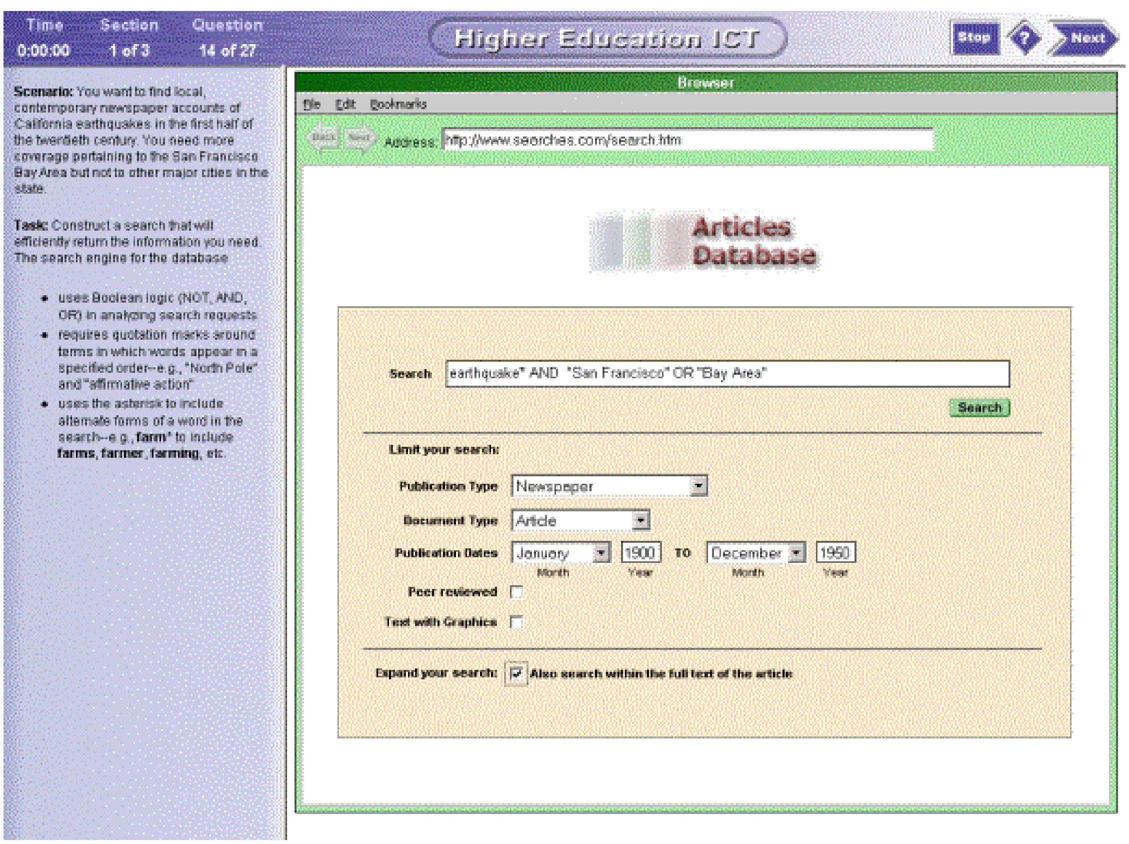

Figure 1. Students demonstrate their skills at handling information through interaction with simulated software. In this example task (designed to take about five minutes), students develop a search query as part of a research assignment on earthquakes. Figure is © 2007, Educational Testing Service. All rights reserved.

Students solve information-handling tasks in the context of simulated software (e.g., email, web browser, library database). Each interactive task, separated into five and 15 minute tasks, uses simulated software with the look and feel of typical applications. The five minute tasks target a single proficiency whereas the 15 minute tasks comprise more complex scenarios. The simpler tasks contribute to the overall reliability of the assessment whereas the more complex tasks focus on the richer aspects of ICT literacy performance.

In the assessment, a student might encounter a scenario that requires her to access information from a database using a search engine (Figure 1). The results are tracked and strategies scored based on how she searches for information, such as key words, sequentially refined search strategies, etc. Her proficiency is estimated based on her ability to identify how well the information returned meets the needs of the task.

The real-world, scenario-based simulation tasks represent a critical aspect of our assessment approach. Knowledge gained about information retrieval and use within an authentic setting, such as a computer lab where students are working on a research project or assignment, or a workplace environment where employees are trying to solve an information-based problem, is more useful than knowledge generated about information seeking behaviors from outside of an authentic context [10].

ICT LITERACY ASSESSMENT SCORES AND ICT LITERACY SKILLS

Before using an assessment to support instructional initiatives, there should be evidence of its validity. In this section, we present an investigation into the validity of the ICT Literacy Assessment: the extent to which scores on the assessment reflect students' ICT literacy skills. A common approach to validating an assessment is to administer the assessment and other measures to a sample drawn from the population of interest (e.g., college students). *Convergent validity* is supported if assessment scores correlate with other measures expected to be related to ICT literacy. *Discriminant validity* is supported if scores do *not* correlate with measures thought to be distinct from ICT literacy. In this study, comparison measures were developed from questionnaires administered to test-takers before they completed the ICT Literacy Assessment.

Participants

Participants were 4048 undergraduate students recruited in January 2005 to take the ETS ICT Literacy Assessment. The students represented 30 college and university campuses, primarily in the western United States. Students were recruited at their local campuses and all data were collected at the campuses. All but two campuses recruited using a convenience sample (e.g., campus flyers). Table 2 shows the demographic and academic characteristics of the participants.

Procedure

Between January and April 2005, the ICT Literacy Assessment was administered at different campuses, and so each administration differed on a number of details such as the time-of-day, nature and timing of incentives (e.g., raffles for iPods, $25 gift certificates), number of students within each session, and location of computer lab on campus. However, certain characteristics remained consistent. Students first completed a demographic questionnaire and academic experiences questionnaire (approximately 30 minutes) before beginning the assessment (two one-hour sections). All testing sessions were proctored. If a student did not complete the assessment within the allotted time, the testing software stopped the section and asked the student to alert the proctor to move the student to the next section of the test or to the exit survey. After completing both assessment sections, students completed an on-line survey concerning their experiences in taking the assessment.

Table 2: Characteristics of analysis sample

Gender		**Year**	
Female	2400 (59%)	Freshman	1261 (31%)
Male	1648 (41%)	Sophomore	625 (15%)
GPA		Junior	1258 (31%)
D or lower	40 (1%)	Senior	904 (22%)
C-	98 (2%)	**Race/Ethnicity**	
C	336 (8%)	African American	367 (9%)
C+ or B-	831 (21%)	Asian	935 (23%)
B	1178 (29%)	Hispanic	682 (17%)
B+ or A-	1157 (29%)	White (non-Hispanic)	1734 (43%)
A	408 (10%)	All others	330 (8%)

Instruments

ETS ICT Literacy Assessment scores. The purpose of the ICT Literacy Large Scale Assessment delivered in early 2005 was to describe the ICT literacy levels of a student population or group in the aggregate (no individual scores). The assessment was delivered using a spiraled design, wherein each participant received tasks that targeted two of the seven proficiencies. Samples of students at each campus were distributed evenly across forms. Raw scores for each test form were separately scaled to a mean of 150 and standard deviation of 35. To simplify analyses, each student's score is treated equally, regardless of the particular test form received. This equating across forms is justified by preliminary analyses that showed high (mid .80s) inter-correlations among the seven ICT literacy proficiency scores.

Because of the spiraled design, reliability metrics could not be calculated. However, in other administrations of comprehensive test forms (all proficiencies represented) that contained fewer assessment tasks, Cronbach alpha reliabilities were .85 and higher.

Self-report measures. Three types of self-report measures were developed from the demographic and academic experiences questionnaire administered prior to the ICT Literacy Assessment. Table 4 provides more details on the measures as well as descriptive statistics.

1. *Self Assessment* measures gauged students' reports of their abilities with activities and skills related to ICT literacy. Self-assessments have been used both for academic and workplace competencies as an alternative to objective testing (e.g., [2]), in comparison with others' judgments, and to validate objective measures (see [14], for a review). Research on self-assessment measures have revealed moderate correlations (mid .20s to mid .30s) between self-assessment and performance measures (e.g., [11], [12]), although correlations differ by domain and self-assessment instrument.
2. *Self sufficiency* measures provide insights into students' capabilities for self-directed learning. ICT literate students identify their own need for information (e.g., "I need to learn about…") and can locate appropriate sources for meeting those needs. Thus, ICT literate students should be able to take greater responsibility for their own learning, having the skills to figure out information problems they encounter on their own (or, at least, know where to go to find answers). Several authors posit a correspondence between ICT literacy and self-directed learning (e.g., [4]), although we are not aware of any empirical studies investigating this connection.
3. *Academic performance* measures reflect students' general academic performance (GPA). Any investigation into the validity of an assessment must investigate whether the instrument assesses the skills of interest rather than reflecting only general academic performance (i.e., good students tend to score better on a wide range of assessments). Of course, some connection between ICT literacy and academic ability is to be expected. For example, better students might be more likely to recognize the importance of ICT literacy skills for their academic and workplace careers.

Results and Discussion

Correlations between the self-report measures and ICT literacy scores are shown in Table 3. Except for frequency of ICT literacy activities, all measures correlate significantly with performance on the ICT Literacy Assessment, supporting the convergent validity of the assessment. The correlations are at a level consistent with research comparing self-report measures of skills to assessment scores (e.g., [11]). GPA correlated only weakly with the self-assessment and self sufficiency measures (not shown, but all *r*s close to zero). Thus, ICT literacy confidence and self-sufficiency are each distinct from academic performance even though, as just stated, all three measures contribute to ICT literacy skill. (i.e., correlate with ICT literacy scores).

Table 3. Correlations with ICT Literacy Scores

Measure Name	**Correlation**
Self-Assessments of Skills	
Confidence in ICT literacy activities	$.27^{***}$
Frequency of ICT literacy activities	-.01
Skills in course technology	$.29^{***}$
Self sufficiency	
Figured out problems on own	$.29^{***}$
Asked for help (reverse coded)	$.26^{***}$
No. of ICT literacy skills learned on own	$.15^{***}$
Academic Performance	
Overall GPA	$.23^{***}$

$^{***}p < .001$

The low correlation between ICT literacy scores and frequency of ICT literacy activities is especially important. Many students believe they have good ICT literacy skills because of their frequent interactions with the Internet. Indeed, there was a strong correlation between the frequency and confidence scales ($r = .67$, $p < .001$). However, only the students' confidence in their skills aligned with their performance on the ICT literacy assessment, supporting the discriminant validity of the assessment. This result provides strong support for instructors' claims that frequency-of-contact does not translate to good ICT literacy skills, and points to the need for ICT literacy instruction.

Table 4. Measures developed from questionnaires

Measure Name	**Reliability (Cronbach alpha)**	**Mean (SD)**	**Questions Comprising Measure**
Self-Assessments of Skills			
Confidence in ICT literacy activities	.94	2.4 (.4)	Mean response for each of 30 ICT literacy activities: *How confident are you in your ability to do this activity?* (1=Not confident to 3=Very Confident)
Frequency of ICT literacy activities	.95	3.2 (.7)	Mean response for each of 30 ICT literacy activities: *About how often you have done the activity over the past two years?* (1=Never to 4=Very Often)
Skills in course technology	.62	3.1 (.6)	Mean of responses to the following three questions: *At the beginning of [your most recent technology-related course], how familiar were you already with the technology you were to use in the course?* (1=Not Familiar to 4=Very Familiar) *In thinking about your experience using the technology in this course, how often did you have trouble using the course technology?* [reverse coded] (1=Very Often to 4=Never) *How confident are you that you could effectively use similar course technologies for another course?* (1=Not Confident to 4=Very Confident)
Self sufficiency			
Figured out problems on own (dummy coded)	N/A*	.35 (.5)	*When you encountered any types of difficulties or problems using the course technology, from what source did you most often seek a solution?* (1=Figured it out myself; 0=all other responses, e.g., faculty, peers)
Asked for help (reverse coded)	N/A*	3.4 (.7)	*In thinking about your experience using the technology in this course, how often did you ask for help from others on how to use the course technology?* (1=Very often to 4=Never)
Number of ICT literacy skills learned on own	.67	3.6 (1.9)	Mean responses for seven ICT literacy skill areas: *From what source did you learn the* ***most*** *about this topic over the past two years?* (1=On my own; 0=Coursework or other training)
Academic Performance			
Overall GPA	N/A*	5.0 (1.3)	1=D or lower; 2=C-; 3= C, C+; 4=B-; 5=B, B+; 6=A-; 7=A

*Because this measure consists of a single question, reliability cannot be calculated.

CONCLUSIONS

This study provides some evidence for the convergent and discriminant validity of the ETS ICT Literacy Assessment, paving the way for its use to evaluate instructional programs on ICT literacy. In current work, we are assessing the effectiveness of an innovative ICT literacy instructional method by comparing student performance on the ICT Literacy Assessment before and after instruction. Our overall goals are to understand how first-year students acquire information-processing skills, identify best practices for integrating information literacy into the curriculum, and assess the impact of skill acquisition on overall academic achievement.

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