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Measuring Information and Communication Technology Literacy using a performance assessment: Validation of the Student Tool for Technology Literacy (ST^2L)

Anne Corinne Huggins, Albert D. Ritzhaupt*, Kara Dawson

University of Florida, USA

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ABSTRACT

This paper reports the validation scores of the Student Tool for Technology Literacy (ST^2L), a performance-based assessment based on the *National Educational Technology Standards for Students* (NETS*S) used to measure middle grade students *Information and Communication Technology* (ICT) *Literacy*. Middle grade students ($N = 5884$) from school districts across the state of Florida were recruited for this study. This paper first provides an overview of various methods to measure ICT literacy and related constructs, and provides documented evidence of score reliability and validity. Following sound procedures based on prior research, this paper provides validity and reliability evidence for the ST^2L scores using both item response theory and testlet response theory. This paper examines both the internal and external validity of the instrument. The ST^2L, with minimal revision, was found to be a sound measure of ICT literacy for low-stakes assessment purposes. A discussion of the results is provided with emphasis on the psychometric properties of the tool and some practical insights on with whom the tool should be used in future research and practice.

1. Introduction

A series of recent workshops convened by the National Research Council (NRC) and co-sponsored by the National Science Foundation (NSF) and National Institute for Health highlighted the importance of teaching and assessing 21st century skills in K-12 education (NRC, 2011). Information and Communication Technology (ICT) literacy, or the ability to use technologies to support problem solving, critical thinking, communication, collaboration and decision-making, is a critical 21st century skill (NRC, 2011; P21, 2011). The National Educational Technology Plan (USDOE, 2010) also highlights the importance of ICT literacy for student success across all content areas, for developing skills to support lifelong learning and for providing authentic learning opportunities that prepare students to succeed in a globally competitive workforce. It is clear that students who are ICT literate are at a distinct advantage in terms of learning in increasingly digital classrooms (NSF, 2006; USDOE, 2010), competing in an increasingly digital job market (NRC, 2008) and participating in an increasingly digital democracy (Jenkins, 2006; P21, 2011). Hence, it is critical that educators have access to measures that display evidence of validity and reliability in scores representing this construct in order to use the measures, for example, to guide instruction and address student needs in this area.

The International Society for Technology in Education (ISTE) has developed a set of national standards for ICT literacy known as the National Educational Technology Standards for Students (ISTE, 2007). These standards are designed to consider the breadth and depth of ICT literacy and to be flexible enough to adapt as new technologies emerge. The standards were modified based on the 1998 version of the standards. NETS*S strands include knowledge and dispositions related to *Creativity and Innovation*, *Communication and Collaboration*, *Research and Information Fluency*, *Critical Thinking*, *Problem Solving and Decision Making*, *Digital Citizenship* and *Technology Operations and Concepts*. NETS*S have been widely acclaimed and adopted in the U.S. and many countries around the world and are being used by schools for curriculum development, technology planning and school improvement plans.

* Corresponding author. School of Teaching and Learning, College of Education, University of Florida, 2423 Norman Hall, PO Box 117048, Gainesville, FL 32611, USA. Tel.: +1 352 273 4180; fax: +1 352 392 9193.
E-mail address: aritzhaupt@gmail.com (A.D. Ritzhaupt).

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Yet, measuring ICT literacy is a major challenge for educators and researchers. This point is reinforced by two chapters of the most recent *Handbook of Educational Communications and Technology* that highlight research and methods on measuring the phenomena (Christensen & Knezek, 2014; Tristán-López & Ylizaliturri-Salcedo, 2014). Though there is disagreement on the language used to describe the construct (e.g., digital literacy, media literacy, technological literacy, technology readiness, etc.), several agree on the key facets that make up the construct, including facets such as knowledge of computer hardware and peripherals, navigation of operating systems, folders and file management, word processing, spreadsheets, databases, e-mail, web searching and much more (Tristán-López & Ylizaliturri-Salcedo, 2014). Such skills are essential for individuals in K-12, post-secondary and workplace environments.

For-profit companies have attempted to measure ICT literacy to meet the No Child Left Behind (USDOE, 2001) mandate of every child being technologically literate by 8th grade. States have employed different methods to address this mandates with many relying on private companies. Many of these tools, such as the *TechLiteracy Assessment* (Learning, 2012) claim alignment with NETS*S. However, most for-profit companies provide little evidence of a rigorous design, development and validation process. The PISA (Program for International Student Assessment) indirectly measures some ICT-related items such as frequency of use and self-efficacy via self-report, but ICT literacy is not a focus of the assessment. Instead, the PISA measures reading literacy, mathematics literacy, and science literacy of 15 year-old high school students (PISA, 2012).

Many states have adopted the TAGLIT (Taking a Good Look at Instructional Technology) (Christensen & Knezek, 2014) to meet the NCLB reporting requirements. This tool includes a suite of online assessments for students, teachers, and administrators and claims to be connected to the NETS*S for the student assessment. The questions of the assessment were originally developed by the University of North Carolina Center for School Leadership Development. This is a *traditional* online assessment that includes a wide range of questions focusing on the knowledge, skills, and dispositions related to ICT literacy. The utility includes a reporting function for schools to use for reporting and planning purposes. However, very little research has been published on the design, development, and validation of this suite of tools for public inspection.

A promising new initiative is the first-ever National Assessment of Education Progress (NAEP) Technology and Engineering Literacy (TEL) assessment, which is currently under development (NAEP, 2014). TEL is designed to complement other NAEP assessments in mathematics and science by focusing specifically on technology and engineering constructs. Unlike the other NAEP instruments, the TEL is completely computer-based and includes interactive scenario-based tasks in simulated software environments. The TEL is scheduled for pilot testing with 8th grade students in the Fall of 2013, and slated for release to the wider public in sometime in 2014. However, if one carefully reads over the framework for this instrument, one will discover the instrument is not designed to purely measure ICT literacy. Rather, the instrument focuses on three interrelated constructs, including *Design and Systems*, *Technology and Society*, and *Information and Communication Technology* (NAEP, 2014).

This paper focuses on a performance-based instrument known as the Student Tool for Literacy (ST^2L) designed to measure the ICT literacy skills of middle grades students in Florida using the 2007 National Educational Technology Standards for Students (NETS*S). This is the second iteration of the ST^2L with the first iteration aligned with the original 1998 NETS*S (Hohlfeld, Ritzhaupt, & Barron, 2010). Specifically, this paper provides validity and reliability evidence for the scores using both item response theory and testlet response theory (Wainer, Bradlow, & Wang, 2007).

2. Measuring ICT literacy

The definition, description, and measurement of ICT literacy has been a topic under investigation primarily since the advent of the World Wide Web in the early nineties. Several scholars, practitioners, and reputable organizations have attempted to carefully define ICT literacy with associated frameworks, and have attempted to design, develop, and validate reliable measures of this multidimensional construct. For instance, in Europe, they have created the *European Computer Driving License Foundation* (ECDLF), which is a framework and comprehensive assessment of ICT literacy skills used to certify professionals working in the information technology industry. This particular certificate has been adopted by 148 countries around the world in 41 different languages (Christensen & Knezek, 2014). We attempt to review some of the published measures of ICT literacy and related constructs in this short literature review. We do not claim to cover all instruments of ICT literacy; rather, we cover instruments that were published and provided evidence of both validity and reliability.

Compeau and Higgins (1995) provide one of the earlier and more popular measures of computer-self efficacy and discuss its implications for the acceptance of technology systems in the context of knowledge workers. The measure is intended to be used with knowledge workers. Building on the works of Bandura (1986), computer-self efficacy is defined as "a judgment of one's capability to use a computer" (Compeau & Higgins, 1995, 192). Their study involved more than 1000 knowledge workers in Canada, and several related measurement systems, including computer affect, anxiety, and use. They designed and tested a complex path model to examine computer-self efficacy and its relationship with the other constructs. Unsurprisingly, computer self-efficacy was significantly and negatively correlated with computer anxiety. Also, computer use has a significant positive correlation with computer self-efficacy. This scale has been widely adopted, and the article has been cited more than 2900 times according to Google Scholar.

Parasuraman (2000) provides a comprehensive overview of the Technology Readiness Index (TRI), which is a multi-item scale designed to measure technology readiness, a construct similar to ICT literacy. Parasuraman (2000) defines technology readiness as "people's propensity to embrace and use new technologies for accomplishing goals in home life and at work" (p. 308). This measure is intended to be used by adults in marketing and business contexts. The development process included dozens of technology-related focus groups to generate the initial item pool followed by an intensive study on the psychometric properties of the scale (including factor analysis and internal consistency reliability). Though the TRI has been mostly used in business and marketing literature, it demonstrates that other disciplines are also struggling with this complex phenomenon.

Bunz (2004) validated an instrument to assess people's fluency with the computer, e-mail, and the Web (CEW fluency). The instrument was developed based on extensive research on information and communication technology literacies. The research was conducted in two phases. First, the instrument was tested on 284 research participants and a principle component factor analysis with varimax rotation resulted in 21 items in four constructs: computer fluency ($\alpha = .85$), e-mail fluency ($\alpha = .89$), Web navigation ($\alpha = .84$), and Web editing ($\alpha = .82$). The 4-factor solution accounted for more than 67% of the total variance. In the second phase, Bunz's (2004) 143 participants