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Online research and learning in science: A one-to-one laptop comparison in two states using performance based assessments☆

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ABSTRACT

Previous studies of one-to-one computing programs have suffered from several methodological limitations and produced mixed results. Especially surprising is that previous studies have not evaluated students' ability to use the Internet to learn from online information. This study evaluated the ability of 1129 seventh grade students, in two different states, to conduct online research and learn in science. One state, Maine, had implemented a one-to-one program for several years, beginning in seventh grade. It ranked 33rd (out of 50 states) in median family income (U.S. Census Bureau, 2012). The other, Connecticut, had yet to implement a similar policy and ranked 4th among all states in median family income. Stratified random sampling was used to select participating students who were representative of each state. The primary measure was a performance-based assessment of online research and learning, with demonstrated validity and reliability. Students completed two online research projects in science on two different days. Results for students in the two states were compared using regression models that conditioned on student prior knowledge and school level indicators of socioeconomic status and teacher experience. The adjusted mean scores for online research and learning were generally significantly higher for Maine, the state that provided laptops to middle and high school students. The overall effect size was comparable to about a half a year of annual growth, the same amount of time that students had access to one-to-one laptops in their classrooms. These results are discussed in terms of their implications for technology investments by state and local educational agencies, especially in light of the new educational standards beginning to appear in Australia, the United States, and other nations. Limitations are also explored.

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1. Introduction

The ability to learn from online information is essential for full participation in today's society (Organisation for Economic Co-operation and Development [OECD], 2010; Rideout, Foehr, & Roberts, 2010) but the ability of our youth in this area appears to be surprisingly limited (Bennett, Maton, & Kervin, 2008; Kuiper & Volman, 2008). Several recent studies highlight the issue. One showed that fewer than 4% of students were able to successfully complete all four tasks required to evaluate the source reliability of a single web site (Forzani, 2015). A second showed that seventh grade students performed successfully on only half of the items required to complete an online research task (Leu et al., 2015). Reports are beginning to detail the important consequences of students unprepared to learn from online information (see, for example, Goodman, Sands, & Coley, 2015; Kirsch, Braun, Yamamoto, & Sum, 2007).

Policy responses are emerging in response to this issue. At the international level, we see assessments being developed that begin to measure online research and problem solving skills among 10-year olds (Mullis & Martin, 2013), students in their eighth year of schooling (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2013), 15-year olds (OECD, 2011), as well as adults (Rouet et al., 2009). At the national level, educational standards now include online research skills in many nations (cf. Australian Curriculum Assessment and Reporting Authority, n.d.; NGSS Lead States, 2013).

In the United States, we see diverse policy responses at the local and state level where districts and states are increasing the integration of online technologies into learning contexts in many different ways. One of the most visible is the movement to one-to-one computing (Argueta, Huff, Tingen, & Corn, 2011). States such as Maine (Silvernail & Gritter, 2007) and school districts in many locations (Bebell & O'Dwyer, 2010) are implementing one-to-one computing initiatives where each student has access to a laptop, Chromebook, iPad, or other computing device, permitting them to learn from online information. This innovation may be one of the more disruptive forces in education (Christensen, Horn, & Johnson, 2008) since it requires substantial investment and change in infrastructure, professional development, district policies, and other aspects of our educational system (see Bebell & O'Dwyer, 2010; and Zucker & Light, 2009; for reviews).

Despite the importance of this innovation, we know little about the effects of one-to-one computing initiatives on learning from online information because, for reasons detailed later in the paper, design limitations in previous studies have limited our confidence in their results. This study directly evaluated students' ability to conduct online research and learn with representative samples of 7th graders in two states. It used performance-based assessments of students' ability to conduct online research and learn in science, an area that is essential to a nation's well being (National Research Council, 2007; President's Council of Advisors on Science and Technology, 2010) and important for classroom learning (Common Core State Standards Initiative, 2015; NGSS Lead States, 2013).

2. Perspectives and theoretical background

2.1. Disciplinary literacy

This study draws upon a Disciplinary Literacy (DL) perspective, especially in Science, Technology, Engineering, and Math (STEM). Disciplinary Literacy argues that literacy and learning practices are defined by the specific needs and purposes of the community in which they operate and are specialized to the discipline in which they are used (Moje, 2007; Shanahan & Shanahan, 2012).

STEM initiatives argue that it is important to systematically prepare students for the technologies that will be central to their future success in science (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011). This preparation includes online research and learning skills (cf. National Research Council, 2011). Consistent with the learning practices of the science community, the present study evaluated students' ability to conduct online research and learn in science.

2.2. New literacies theory

This study is also informed by New Literacies theory (Leu, Kinzer, Coiro, Castek, & Henry, 2013), a dual-level theory for literacy and learning developed around continuous changes in learning technologies. In an online age, a defining aspect of learning technologies is that they rapidly and continuously change. By the time we build a body of research results for a new technology with the complexity and richness that we require, it has morphed into a different form, divided into multiple forms, or disappeared altogether, replaced by a superior technology (Leu, 2000). This makes it difficult to connect results, over time, from a line of research in learning technologies. The continuous changes taking place raise an important conundrum for both theory and research: How can we develop adequate theory to design research when the nature of learning technologies are ephemeral, continuously being redefined as new ones appear?

New Literacies theory conceptualizes the technologies for learning and literacy on two levels: lowercase (new literacies) and uppercase (New Literacies). Lowercase theories explore a specific Internet technology, such as text messaging (e.g., Lewis & Fabos, 2005; Wood, Jackson, Hart, Plester, & Wilde, 2011) or a focused disciplinary base, such as the semiotics of multimodality in online media (e.g., Kress, 2003) or gaming (Squire, 2011). As such, research based on lowercase theories stays closely in touch with the rapid changes taking place with diverse, continuously new technologies. Common findings across multiple lines of theory and research may then be integrated into a broader, uppercase theory of New Literacies. This