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Online Research and Learning as Measured by Performance Based Simulations: The Effects of a State One-to-One Initiative with Middle School Science Students

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The Effects of a State One-to-One Initiative with Middle School Science Students

Clint Kennedy

University of Connecticut

2017

Abstract

This study investigated how students in two states, one with and one without a state-wide one-to-one laptop program, performed on measures of online research and learning in science. The study replicated and extended the findings of a recent study using more current and more extensive data. In general, this study adds to the body of research looking specifically at the integration of Internet-based technology into teaching and student learning (Leu, Forzani, Rhoads, Maykel, Kennedy & Timbrell, 2015; Lankshear & Knobel, 2011; Greenhow, Robelia & Hughes, 2009; Jonassen, Howland, Moore & Marra, 2002). Additionally, this study examined the extent to which several important individual differences affect students' ability to perform online research in science: socioeconomic status, teacher experience, student offline reading measures, and student prior knowledge. Participants (N = 1,628) included seventh grade students from two states in the Northeast section of the United States. Between groups analysis of variance was used to compare mean differences in covariate demographic data between the students in the two states. Results for students in the two states were compared using a regression model that conditioned on the school level indicators of socioeconomic status, teacher experience, and student prior knowledge. The primary measure was a performance-based assessment of online research and learning, with demonstrated validity and reliability (Leu et al., 2014). The relationship between instructional and

technology practices and student performance on online research was investigated with results to be used to inform more optimal instructional practices and conditions for student success. Results were discussed in the context of their implications for both research and instructional practice in the classroom.

Online Research and Learning as Measured by Performance Based Simulations:
The Effects of a State One-to-One Initiative with Middle School Science Students

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B.S.E., University of Pennsylvania, 1997

M.A., University of Connecticut, 2004

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

at the

University of Connecticut

2017

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Clint Kennedy

2017

APPROVAL PAGE

Doctor of Philosophy Dissertation

Online Research and Learning as Measured by Performance Based Simulations:
The Effects of a State One-to-One Initiative with Middle School Science Students

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CHAPTER 1

BACKGROUND AND OVERVIEW OF THE STUDY

“Access to high-speed broadband is no longer a luxury; it is a necessity for American families, businesses, and consumers. Affordable, reliable access to high-speed broadband is critical to United States economic growth and competitiveness. High-speed broadband enables Americans to use the Internet in new ways, expands access to health services and education, increases the productivity of businesses, and drives innovation throughout the digital ecosystem.”

President Barack Obama (2015)

Introduction

Access to the Internet, according to United States President Barak Obama, is a necessity for American families, businesses, and consumers (The White House, 2015). Necessity of access does not, however, guarantee that citizens, employees, and customers have the skills and knowledge to use the Internet, and specifically the Web, effectively. The ability to learn and perform research online is essential for full participation in our formal educational institutions as well as for students to be fully prepared for college, career, and life (Organisation for Economic Co-operation and Development, 2010).

However, the ability of adolescents to complete even the most basic of tasks in this area appears to be surprisingly limited (Stanford History Education Group, 2016; Carnevale, Smith, Strohl, 2013; Bennett, Maton, & Kervin, 2008; Kuiper & Volman, 2008). In a recent study (Kennedy, Rhodes & Leu, 2016), students performed poorly on performance assessments measuring online research and learning with only modest gains for those with access to a school based one-to-one laptop program. Another study showed that fewer than 4% of students were able to complete all four tasks required to evaluate the source reliability of a single web site (Forzani, 2015). A third study revealed that seventh grade students performed successfully on about 50% of the items required to complete an online research task (Leu, Forzani, Rhoads, Maykel, Kennedy, & Timbrell, 2015). Additional accounts addressing the important

consequences of students being unprepared to learn from online information are surfacing as well (Goodman, Sands, & Coley, 2015).

Policy responses are beginning to emerge to address the lack of focus on the assessment of online research and learning skills. Around the world, we see evidence of international assessments being developed that measure online research and problem solving skills among primary students (Mullis & Martin, 2013), 15-year olds (Organisation for Economic Co-operation and Development, 2011), as well as adults (Rouet et al., 2009). In individual countries, we are seeing the development of educational standards that now include online research skills (NGSS Lead States, 2013; Australian Curriculum Assessment and Reporting Authority, n.d.; Common Core State Standards Initiative, 2010).

In the United States, we see a variety of regulation and policy responses at the state, county, and district level where decision makers are stressing the importance of the integration of online technologies into curriculum and instruction. The movement that is most prominent currently is the integration of a one-to-one computing model (Argueta, Huff, Tingen, & Corn, 2011). School districts in many locations across the United States (Bebell & O'Dwyer, 2010) and individual states such as Maine (Silvernail & Gritter, 2007) are implementing one-to-one computing initiatives where each student has access to a laptop, Chromebook, iPad, or other computing device, permitting them to access and learn from online information. Laptops for every student may be one of the more disruptive innovative forces in education (Christensen, Horn, & Johnson, 2008) since it requires a substantial change in infrastructure, professional development, district policies, as well as other aspects of our educational system (Argueta, et. al, 2011; Bebell & O'Dwyer, 2010; Zucker & Light, 2009).

The ability to perform research and learning tasks online is one of the most important skill sets required by today's learners that they currently don't possess (Purcell, Rainie, Heaps, Buchanan, Friedrich, Jacklin, & Zickuhr, 2012). Finding and identifying reliable online information, in a world where digital publishing has been democratized, relies upon new and effective online research skills (Bennett, Maton, & Kervin, 2008; Eagleton, Guinee, & Langlais, 2003). However, these skills are often the areas in which many of our students over estimate their abilities and struggle greatly (Kuiper, 2007). High-level online research skills have become prerequisites for learning in an online and digital age (Vockley, 2007). Now that research has almost completely moved from physical-based media to digital-based media and has become a ubiquitous part of our lives for learning (Purcell et al., 2012; Purcell & Rainie, 2014), an increased focus on analyzing the components of and teaching strategies for online research and learning must be a priority for researchers and practitioners alike (Goldman, Braasch, Wiley, Graesser, & Brodowinska, 2012).

Purpose

There are two purposes to this study:

1. Re-examine the results of the findings of a study of one-to-one laptop use by Kennedy, Rhoads & Leu (2016) through a replication study using a larger, different data set with more reliable measures.
2. Extend the understanding of the findings through the investigation of results from a more comprehensive set of teacher and student Internet use surveys.

This proposed study therefore seeks to initiate a better understanding of 7th grade middle school students' online research capabilities within the area of science specifically identifying the instructional practices and contexts that best predict online research and learning success. This

study seeks to do so by building directly on emerging findings around online research, the unique aspects of simulation-based performance assessments, and important individual differences in students' science and research skills. Specifically, the purpose of the proposed study therefore is to investigate how well seventh grade students perform research online in science in one state with a one-to-one laptop policy and a second state without such a policy and to identify the variables that contribute most to these differences. This study is part replication study, which will build on the work previously done by Kennedy, Rhodes, and Leu (2016). The data to be used in this proposed study come from a new wave of data, year 4 of the ORCA Project (Leu et al., 2015).

It is the hope of the author that the findings from this proposed study will provide teachers and researchers with a better understanding of middle school students' abilities to learn and perform research online, a highly important area but one about which we still have little information. Moreover, the findings will provide important evidence that can be used in classrooms to improve science instruction for online student learning and for research regarding student use of technology and teacher use of performance assessments.

Background for the Study

Despite the importance of online research and learning skills (Goldman et al., 2012), we are only beginning to understand the skills required by adolescent students to conduct research online (Leu, Forzani, Rhoads, Maykel, Kennedy & Timbrell, 2015) and what learning results from their current abilities (Goldman et al., 2012; Silvernail, Pinkham, Wintle, Walker & Bartlett, 2011). To date, there has been only one study that used a representative sample of students and an outcome measure tied to the type of learning one might expect from online research in one to one computing contexts. That study directly evaluated students' ability to

conduct online research and learn with representative samples of grade 7 students in two states (Kennedy et al., 2016) and used performance based assessments of students' ability to conduct online research and learn in science, an area that has been called essential to a nation's well-being (National Research Council, 2007).

The ability to create meaning from what is read during online research and learning is important to knowledge-based societies (PIAAC Expert Group in Problem Solving in Technology-Rich Environments, 2009; Goldman, et al., 2012). Recent studies have shown that the tasks students perform when completing online research are not isomorphic with offline learning (Leu et al., 2014). There appears to be a relationship between the offline and online research skills required for learning, but many additional skills have been identified as necessary when students move to conducting research for learning online (Afflerbach & Cho, 2009; Coiro & Dobler, 2007; Hartman, Morsink, & Zheng, 2010). Afflerbach & Cho (2009) reviewed 46 studies that focused on reading strategies used during online research. Their analysis and subsequent results showed evidence of strategies that "...appeared to have no counterpart in traditional [text based] reading" (p. 217). A portion of the strategies identified centered around a student's ability to apply methods to reduce their levels of uncertainty, while navigating and negotiating appropriate reading paths in a shifting problem space.

A study by Coiro & Dobler (2007) found that online research and learning involved the use of traditionally taught offline reading skills, but that more complex additional skills were necessary. This argument supports earlier findings that although there is a relationship between scores on high-stakes state reading assessments and an assessment of online research it is a smaller than expected correlation, specifically in this study between an online reading comprehension assessment and a measure of degrees of reading power (DRP) as part of the state

assessment (Leu et al., 2005). A second study used a model to predict online research performance that conditioned on offline reading and prior knowledge scores (Coiro, 2011). The study found that an additional 16% of variance could be accounted for if one knew a participating students' previous online research ability. It would follow from this study that additional skills, above and beyond skills required for offline reading and any measurement error, are required for online research. Additional case studies have shown that students, who perform poorly on high-stakes state reading tests in certain contexts, perform at unexpectedly high levels on tasks of online research (Leu et al., 2015).

Why is a difference between offline and online research important? If the two were isomorphic, the same skills, including traditional reading strategies, could be applied for online learning with high degree of assumed success. Based on current evidence, because the two appear to require somewhat different strategies suggests that teaching and learning in the online research domain should require different instructional approaches. Preliminary work has suggested that a gap in online research and learning ability exists based on income inequality as well as other covariates including prior knowledge (Henry, 2006).

As the importance of STEM education has gained increased attention over the last five years in United States public schools (Executive Office of the President of the United States, 2013). Teaching STEM concepts and the scientific literacy skills behind them is critical for effective teaching of STEM concepts with students (Cervetti, Pearson, Bravo, and Barber, 2006). The core skill involved in what it means to engage in STEM work through scientific literacy is research. Teaching generic research literacy skills without teaching the specific skills and knowledge associated with online research is not likely to support this process or be effective (Kardash, 2000).

Also, little is known about the effects of one-to-one computing initiatives on learning specifically due to design limitations in previous studies that have limited confidence in published results (Kennedy et al., 2016). For example, until just recently, not a single study had directly evaluated the impact of computer use on students' ability to learn from online information. A recent study did find some evidence of schools with one-to-one laptops having statistically significant and positive standardized regression coefficients on student learning in science. Using socio-demographic, school and examination data, the study used multiple regression analyses to measure the impact of a t-to-1 laptop provision and other variables on student attainment in biology, chemistry and physics. A small to medium effect size was found when using external examinations (Crook, Sharma, Wilson, 2015). However, the ability to learn specifically from online information was not included.

Advocates of non-traditional assessments suggest that the wider use of performance based assessments and related instructional approaches have the potential to transform the classroom learning experience (Rothman, 1995). Performance based assessments typically represent a set of strategies for the application by students of work habits, knowledge, and skills through a series of tasks that are meaningful and engaging to students (Hibbard, 1996). This type of assessment can provide classroom teachers with important information to make better instructional decisions based upon how a student understands and applies knowledge. Under some circumstances, performance based assessments can be a catalyst for specific instructional behavior and procedure changes in the classroom more easily than general teaching paradigms (Firestone, Mayrowetz, & Fairman, 1998). As Wiggins (1993) discusses, the aim of assessment is primarily to educate students and improve student performance, not merely to audit the student's current understanding. Assessment, according to Wiggins, is of little value "unless it is

educative—that is, instructive to students, teachers, and school clients and overseers.” Darling-Hammond (1994) argues that it is necessary to have policy and practice in place to ensure the assessment are used to give teachers practical information on student learning and to provide opportunities for school communities to engage in self-reflection (Darling-Hammond, 1994).

Initial Study and Replication

This study was conducted to replicate and extend the findings of a recent study using more current and more extensive data (Kennedy et al., 2016). The data from the replicated study (pilot study in year 3) and this current study (validation study year 4) were collected as part of a five-year research project (the ORCA Project) to design to develop valid, reliable, and practical assessments of online research and reading comprehension for the schools of our nation. The ORCA (Online Research and Comprehension Assessments) was a five-year research project designed to initiate research to develop valid, reliable, and practical assessments of online research and comprehension for the schools in the United States.

The initial study (Kennedy et al., 2016) compared the online research skills of students in Maine, a state with a one-to-one laptop initiative, to the skills of students in Connecticut, a state that has not yet implemented a statewide one-to-one initiative. To isolate the influence a laptop initiative may have from other factors, the study accounted for key correlates of online research that may have had different distributions across the states. District socioeconomic status of students and student prior knowledge was significantly different between the states whereas teacher experience between the states did not vary significantly. The results seemed to show modest gains resulting from Maine’s one-to-one policy, despite the relatively short time frame during which students had access to laptops before being assessed. Results also indicated a generally inadequate level of performance with online research and learning skills and speculated

that additional professional learning opportunities are most likely needed to increase the value of one-to-one laptop initiatives for online research and learning (Kennedy et al., 2016). Ultimately, both greater technology access and improved pedagogy will be required to prepare students for the new learning challenges afforded by increased access to online information.

Why is this study important to be replicated? One-to-one programs are very expensive innovations (Fleischer, 2012). A decision for a school district, county, or state to go one-to-one is best made after several studies consistently demonstrate positive results regarding student achievement as defined. In addition, it was found that Year 4 ORCA-Simulated assessments are substantially more reliable than the assessments used previously (Leu, Maykel, Forzani, and Kennedy, 2014). The new assessments included only two of the three original formats and four of the original eight topics. The current study extends the previous study by evaluating connections between gains in online research skill and instruction in the classroom.

Makel, Plucker, and Hagerty (2012) believe that as a general rule of thumb, if a publication is cited 100 times, it should be replicated. They believe such a guideline may help to avoid flawed findings going unquestioned over an extended period. In this case, the study being replicated has only recently appeared and thus has not been cited over 100 times. However, the three foundational studies the paper is based upon, Leu (2000), Leu, Kinzer, Coiro, and Cammack (2004), and Leu et al. (2007), have all been cited well over one hundred times.

Replication studies are vital to science. By replicating studies, science and the associated findings become part of a self-correcting system. Recent discussions in psychology science specifically have centered around the nature and quality of research (Asendorpf et al., 2013; Pashler & Wagenmakers, 2012; Yong, 2012). Increasingly, one of the major topics discussed in regards to the nature and quality of research is the role of replication. A review by Makel,

Plucker, and Hagerty (2012) found that since 1900, the 100 psychology journals with the highest 5-year impact factors included only 1.07% of studies that were replications. The same study found that the frequency of replications over time flattened between the 1990s and 2000s but appear to be increasing in the 2010s and continue their rising trend. Given the reality of low replication rates overall, the need to increase replication, as a standard practice of educational researchers, is apparent. If educational research is to continue as a critical component for developing progressive educational policy, conducting replications is essential (Makel, Plucker, and Hagerty, 2012).

Methods Overview

Participants

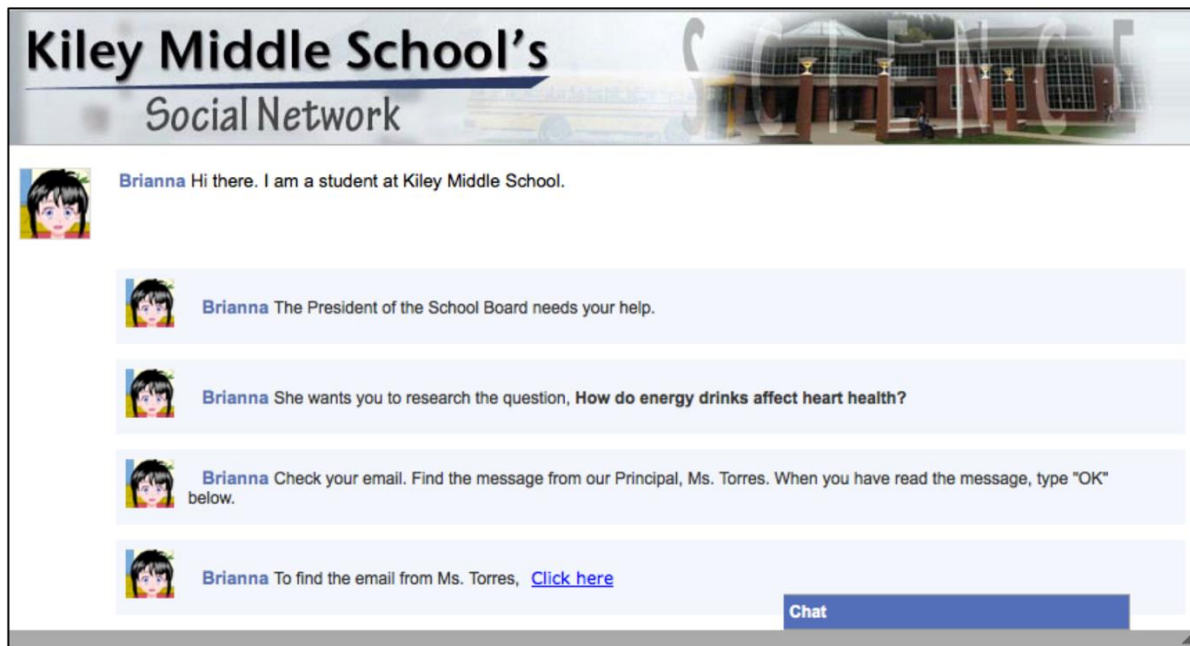
Participants include seventh grade students who participated in Year 4 of the five-year ORCA Project study examining students' online research and learning ability. This study includes all students who took at least one of the ORCA-Simulated assessments as part of The ORCA Project (Leu, Kulikowich, Sedransk, & Coiro, 2009-2014). A total of 1,628 students from two different states in the Northeast participated in this proposed study. This total includes 851 students from Connecticut and 777 students from Maine. The total includes 803 male students and 825 female students. The students were enrolled in 17 school districts in Connecticut and 23 school districts in Maine. Students attended only one of the schools in each school district.

Instrumentation

Data from the online research and learning assessment used in this study come from student assessments using the ORCA-IIs. The ORCA-II is an assessment that was designed and developed from a five-year federal grant to assess middle school students' ability to conduct research online in science by the New Literacies Research Lab at the University of Connecticut

(Leu et al., 2009-2014). The original ORCA was designed for use during Year 3 of the ORCA Project grant (Leu et al., 2009-2014) and was used in the study being replicated. Prior to creation of the original ORCA, two rounds of testing were conducted. Students worked within a social network environment as the avatars provided prompts and students typed their answers into a comment box (Figure 1.1). Students conducted research using a closed Internet-like simulated system and a search engine called “Gloogle.” Students also were prompted to type notes into a notepad as they read different articles on different websites.

Figure 1.1. Social Network Tool Introducing the Research Task in the ORCAs



Covariates

Prior to engaging in each day of the ORCA, students were asked to complete a short multiple-choice assessment designed to measure their prior knowledge on the science topic that was the focus of their assigned ORCA for the day. During the ORCA administration, students completed a survey consisting of demographic questions (Figure 1.2). In each state, data were also collected at the school level including the percent of students on free and reduced price

lunches as a measure of socioeconomic status (SES) for the school. Percent of students taking advantage of free and reduced price lunch in a school has been shown to be a valid proxy for overall school SES. The measure of students utilizing free and reduced lunch is significantly correlated with the percent of families living in poverty in a given community (Nicholson, Slater, Chriqui, & Chaloupka, 2014). These data were obtained from the state department of education websites for each of the two states involved in the present study. The Offline Reading Measures, or ORMs, were developed and validated during the pilot year of the ORCA Project.

Figure 1.2. Demographic Data Collection Screen in the ORCA

The screenshot shows a web interface titled "Log In" in bold black text. Below the title, a red instruction reads "NewLit, please provide us with the following information:". A red rectangular box encloses the data entry fields. Inside the box, there are two labels: "My gender:" and "The primary language that is spoken at my house is:". Each label is followed by a dropdown menu. The "My gender:" dropdown shows "Female" with a small up/down arrow. The "The primary language that is spoken at my house is:" dropdown shows "English" with a small up/down arrow. Below these fields, centered, is a button labeled "Continue".

Data Collection and Scoring

Data were collected on each of two different assessment days. Students were randomly assigned to two different assessment topics (energy drinks, video games, snacks, or contact lenses) as well as to two different formats (ORCA-MC or ORCA-Simulated). Format order was randomized. Due to some absences and technical difficulties, some students were unable to

complete both assessments. Overall, 1,628 students completed the ORCA-Simulated. All formats of the ORCA-Simulated were scored using a binary (0-1) scoring system.

Analyses

An analysis was completed to compare mean differences in covariate demographic data and Internet use survey data between the students in the two states. Results from the pilot year study and the current validation year study were compared throughout to demonstrate similarities and differences found in this replication and extension study.

Significance of the Study

The importance of online information for learning in school classrooms will almost certainly increase over time (Christensen, Horn, & Johnson, 2008). One state, North Carolina has recently passed legislation that requires all local curriculum (standards, content, resources, and instructional tools) to be digitized in public school systems in the state by 2017 (Session Law, 2013).

Currently, a large number of job openings in the United States in science and science related fields, as well as other knowledge worker jobs in general, are going unfilled due to a lack of qualified candidates (Mangan, 2013; Rothwell & Ruiz, 2013). Unfortunately, much of the blame for this unmet demand falls on a United States educational system and its inability to prepare students for these jobs. In 2011, only 32% of United States eighth graders were at or above Proficient on the NAEP science assessment (National Center for Education Statistics, 2011). Today's students must both learn the traditional skills and knowledge in the scientific domain and the scientific literacy skills necessary for real scientific work (Cervetti et al., 2005). This must all be done within a new, digital environment including, most importantly, the Internet (CCSS, 2010).

In addition to traditional scientific knowledge and skills it is now expected that scientific literacy skills necessary for scientific work (Cervetti et al., 2005; Osborne, 2002) include and will be learned within the context of the Internet (CCSS, 2010; NGSS Lead States, 2013). According to the United States Common Core standards, students completing 8th grade are expected to consider information sources when conducting research. Specifically, the standard (CCSS.ELA-LITERACY.W.8.8) states that 8th grade students should “assess the credibility and accuracy of [...] multiple print and digital sources (CCSS, p. 44).” Furthermore, by 11th grade, students should “assess the strengths and limitations of [...] multiple authoritative print and digital sources.” Understanding students’ abilities to conduct research online in 7th grade science will support efforts to assure that students are prepared with the skills necessary to conduct online research at the high school and college levels. In addition, the Next Generation Science Standards, which require “access to digital resources” (NGSS Lead State, 2013) make it clear that these online learning skills are necessary for successful scientific work now and in the future.

For a variety of reasons, previous research on one-to-one laptop initiatives has not been able to provide much useful information on the efficacy of this expensive investment. This proposed study seeks to replicate the aforementioned previous study that found modest but significant positive outcomes on a one-to-one initiative. In the previous study, the adjusted mean scores for online research and learning were generally significantly higher for the state that provided laptops to middle school students. The overall effect size was comparable to about a half a year of annual growth of standardized reading scores at the middle school level, the same amount of time that students had access to one-to-one laptops in their classrooms (Bloom, Hill, Rebeck, Black, and Lipsey, 2008).

This study also seeks to improve upon previous work in this field with an innovative, performance based assessment of learning from online information. Given the generally inadequate level of performance by students with online research and learning skills (Leu et al., 2015), this study hopes to inform professional development work for practicing teachers by identifying successful instructional practices that are related to successful online research and to more completely maximize the value of one-to-one laptop initiatives. Ultimately, this study will look to identify if both greater technology access and improved pedagogy will better prepare students for the new learning and life challenges necessitated by an increasing move to digitize information.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

This study investigated the nature of students' ability to perform on measures of online research and learning in science. These skills, locating, evaluating, synthesizing, and communicating information, are included in the list of the most important skill sets required by today's learners that they currently don't possess (Purcell et al., 2012). This study further explored the impact of individual difference variables that included prior knowledge, socioeconomic status, teacher experience, and offline reading ability on students' online research abilities within the context of science research tasks.

The literature review for this study is framed around a selective review process (Maxwell, 2006). This type of review includes studies that have important implications for the design, conduct, or interpretation of the study (Maxwell, 2006, p. 28). Krathwohl and Smith (2005, p. 29) describe the tasks of a literature review for dissertations purposes to include a select group of studies that provide a foundation for the work, sufficient detail of relevance to the research questions, and specific descriptions regarding the contribution and future implications to the domain. These tasks will be covered in the following literature review. This study is framed by four perspectives that make up the theoretical framework related to students' ability to perform research and learn online in science. These perspectives include: 1) a disciplinary literacy (DL) framework for Science; 2) New Literacies Theory; 3) Constructivist Learning Theory; and 4) Performance Assessment Theory. Related prior research in the areas of scientific literacy, technology for learning, performance based assessments, and previous assessments for online research and learning are also included as context for this study.

As the Internet becomes an increasingly important and central tool for learning and science research, especially, (Horrigan, 2008; Obama, 2015; Thomm & Bromme, 2016; Tsai, Hsu & Tsai, 2012), understanding students' abilities and skills as they are framed and influenced by these theories and research areas is key for developing future instruction targeted to science students' needs.

Theoretical Framework

Crossing many disciplinary boundary, this study is framed around multiple perspectives: 1) disciplinary literacy (DL); 2) New Literacies Theory; 3) Constructivist Learning Theory; and 4) Performance Assessment Theory. Using multiple perspectives, like this, provides a richer and more complete framework (Labbo & Reinking, 1999) for studying the issues in this investigation.

Disciplinary Literacies

This study draws upon a Disciplinary Literacy (DL) perspective, specifically in Science, Technology, Engineering, and Math (STEM). Disciplinary Literacy holds that learning practices are defined by the purpose and needs of the practitioners in which they are being used (Moje, 2007; Shanahan & Shanahan, 2008). STEM programs across the United States currently base curriculum decisions on the premise that it is critical for schools to prepare students in the use of the tools that will be central to their future success in science (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011). Disciplinary literacy refers to the literacy skills that are specialized to the discipline in which they are used (Shanahan & Shanahan, 2008). In the present study, the process of learning while performing online research is viewed as occurring through an interaction of learner, online text and multimedia, and context

on the Internet. Online learners actively construct meaning from disciplinary (science) information by utilizing the resources of the disciplinary (science) activity.

The release of the Next Generation Science Standards (NGSS Lead States) in 2013 is the start of a new round of educational reforms for STEM education at the state and local levels. The main idea behind creating new science standards was to clearly describe comprehensive science content and abilities (Bybee, 2014). The standards include specific tasks students should know and be able to do including obtaining, evaluating, and communicating information (National Research Council, 2011) which are very similar to student tasks in the ORCA. Specifically, as an example, middle school students are asked to gather, read, and synthesize information and data from multiple appropriate sources and assess the credibility, accuracy, and bias of each source (National Research Council, 2011). Thus, this study, in alignment with the learning practices of the science community and the NGSS, analyzed students' ability to conduct online research and learn in science. In this study, the term *scientific literacy* is used to refer to the idea of DL in STEM. Specifically, scientific literacy includes the ability to perform online research and learn in ways that are specific to the tools and discipline of science and a critical part of science teaching and learning.

New Literacies Theory

This study is also informed by New Literacies theory (NLT) (Leu, Kinzer, Coiro, Castek, and Henry 2013). NLT is a dual-level theory for literacy and learning based upon the continuous changes observed in technologies designed for teaching and learning. Since the mainstream adoption of the Internet, the rapidly and continuously changing ecosystem of hardware, software, and digital services is the defining aspect of learning technologies (Ellis & Loveless, 2013). Building a substantial body of knowledge based on research therefore becomes incredibly

difficult in this type of ecosystem. Researchers need sufficient time to design, build, analyze, and publish research results on the effectiveness of a new technology. In this new ecosystem, by the time these research components are in place the technology being studied has typically been replaced or evolved into a different form (Leu, 2000). NLT looks to address these theoretical and practical issues by embracing the characteristic of change inherent to and so critical for the studying of and learning with these new literacies.

NLT conceptualizes the technologies for literacy and learning on two levels: lowercase (new literacies or n.l.) and uppercase (New Literacies or N.L.). Lowercase n.l. explore a specific Internet related technology, such as social media or instant messaging (e.g., Wood, Jackson, Hart, Plester, & Wilde, 2011). They also address a specific, more focused disciplinary base, such as online fan fiction (Black, 2008) or gaming (Apperley & Walsh, 2012). Common findings across multiple lines of theory and research regarding n.l. can be brought together into the broader theory of N.L. This uppercase theory of N.L is likely to be more stable since it only includes those elements common across many, continuously changing technologies (Leu et al., 2013).

A common finding across many areas of n.l. is that more connected environments make new social practices for learning possible with new technologies such as text messaging, wikis, blogs, email, search engines, and social networks (Greenhow et al., 2009). This study specifically investigated N.L. principles that were implemented via the n.l. of online research and learning with performance-based assessments that included the social practices associated with these technologies.

New Literacies of Online Research and Learning

The new literacies of online research and learning (Leu et al., 2013) is one of many n.l. theories. This view suggests that at least five cognitive processing practices occur during online research

that include both traditional and new skills and strategies in five key areas: 1) reading to define important questions or problems (Leu, Kinzer, Coiro, & Cammack, 2004); 2) reading to locate information (Bilal, 2000; Guinee, Eagleton, & Hall, 2003); 3) reading to evaluate information (Sanchez, Wiley, & Goldman, 2006); 4) reading to synthesize information (Goldman et al., 2005; Leu, et al., 2013; Jenkins, 2006); and 5) reading and writing to communicate information (Greenhow et al., 2009). This n.l. theory informed the study as it describes the specific practices that occur when we conduct online research to learn:

1. defining important questions;
2. locating information;
3. evaluating information;
4. synthesizing information; and
5. communicating information.

The last four practices (locating, evaluating, synthesizing and communicating information) constitute the main outcome measures in the ORCA.

Defining Important Questions or Problems. When a student conducts online research to learn he/she typically seeks to solve a problem or answer a question (Leu et al., 2013).

Previous research found that student learning directed by a predetermined, inquiry-based, problem solving task differs from learning that is not (Taboada & Guthrie, 2006). Each of the online research tasks that students completed in this study began with a question in science provided by an avatar that aimed to mirror an authentic online learning task as closely as possible.

Locating Online Information. Locating information is typically the first step in the online research process. To successfully locate information online, students must have the ability

to generate and use effective keyword search strategies (Kuiper & Volman, 2008). Students must also be able to effectively analyze search engine results (Henry, 2006) and to scan efficiently for relevant information within returned sites drawing appropriate inferences (Rouet, Ros, Goumi, Macedo-Rouet, & Dinet, 2011). Consequently, the ORCA includes items designed to assess a students' ability to query, scan, and analyze using a search engine as it supports their work through a particular learning problem.

Evaluating Online Information. Successful online learning must include the ability to critically evaluate information located on the Internet (Bråten, Ferguson, Strømsø, & Anmarkrud, 2014). Research on evaluating information online has focused on information quality, including credibility and relevance (Kiili, Laurinen & Marttunen, 2008). The replicated and current study investigates how well middle school students investigate author and publisher credibility (Bråten, Strømsø, & Britt, 2009) at sites they locate in the ORCA. The students are also asked to identify the quality of the information at those sites as determined by evidence of author expertise and information quality (Goldman et al., 2012).

Synthesizing Online Information. The ability to synthesize information from multiple online sources is a critical next step for student learning after they have located and evaluated information (Goldman & Scardamalia, 2013). Learners typically face additional challenges to coordinate and synthesize vast amounts of information, presented in multiple media formats, using a variety of tools online. The ORCA that is used in this study and this proposed evaluates students' ability to synthesize the science information they previously located and evaluated.

Communicating Online Information. A final practice of student online research involves their ability to communicate via the Internet. Specifically, students are asked to communicate their synthesized findings via a simulated social network, text messaging tool, a wiki, and/or email

which requires them to demonstrate new knowledge, skills, and social practices (Coiro & Dobler, 2007). Communicating with other students in order to obtain information or to share what one has found is an important part of online research (Britt & Gabrys, 2001) and is measured extensively thru the ORCA.

Constructivist Learning Theory

Constructivist learning theory, or constructivism, describes learning as a change in one's understanding of meaning constructed from experience (Newby, Stepich, Lehman, and Russell, 1996). Moreover, constructivism claims that reality is more in the mind of the learner as the learner constructs his/her interpreted reality, based upon his/her mental process of assimilating ideas into the body of ideas he/she already possesses (Jonassen, 1991). For learning and transfer of knowledge to be successful in students, teachers must situate student learning in an environment based on constructivist principles (Brown and King, 2000). Skills and knowledge should not be divided into different subjects, but should be discovered as an integrated whole for learning (McMahon, 1997). However, some studies have shown that the implementation of constructivist modes of instruction with fidelity are found to be associated positively with student learning outcomes in countries with medium and high levels of achievement and negatively with countries with low levels of learning outcomes achievement (see Zuzovsky, 2013). These particular findings suggest that replacing teacher-centric (traditional) instructional practices with more student-centric (constructivist) instructional practices does not necessarily result in more student learning.

Time on Task and Constructivism. There is a tradition for the use of time, specifically time on task, in education (Bloom, 1974) to evaluate student performance. Numerous studies confirm a positive relationship between traditional instructional practices and time on task

(Zuzovsky, 2013). The main challenge for research is the use of different definitions for the overall construct of time on task for learning (Karweit & Slavin, 1982). Differences in these definitions of “on task” and “off task” learning, in addition to other phenomena, have led to the significant and important inconsistencies in this research domain (Karweit & Slavin, 1982). Karweit (1984) warns of that the interpretation of significant findings related to any time on task research requires caution and additional careful consideration. Time on task is defined by Berliner (1991) as “the amount of time students spend engaged in or paying attention to tasks that are related to outcome measures of learning or achievement.” An extensive summary of studies regarding time on task in the classroom in the early 80’s (Karweit, 1984), well before technology in the classroom included digital technologies, concluded that the effectiveness of time on task, while important, is minimal. Instructional practices evolve as tasks develop and lead to others, as students' engagement and understanding waxes and wanes, and organization changes (Lampert, 2001) which makes the measurement of time on task difficult when related to instructional practice.

Time presents a major characteristic of the task completion process. Psychologically, time on task has two different often opposing associations (Goldhammer et al., 2014). On the one hand, spending more time may be positively related to the outcome as the task is completed more carefully. On the other, the relation may be negative if working more fluently, and thus faster, reflects higher ability level. Learning to leverage time efficiently is a critical skill for students and teachers. Allocating realistic amounts of time means effective learning for students and effective instruction for teachers. New technologies, at times, can dramatically improve time on task for students and faculty members (Chickering & Ehrmann, 1996). However, in a technology rich constructivist classroom, the traditional benefits of time on task may not occur

based on a technology distraction factor. Studies have discussed the time wasted when technology is used to distract students during instruction (see Aagaard, 2015; Sana, Weston, & Cepeda, 2013).

Time on task is not synonymous with and should not be confused with engaged time. Time on task has a more restricted and complex definition. Engagement may be observed or recorded when a student is deeply involved in an academic teacher assigned task or for pleasure reading during a time period allocated for science. Time on task, however, would only be recorded when the task in which students were attending to was science. Time on task as a variable in empirical research is usually measured in the same ways as engagement, though when the distinction noted above is kept in mind, the curriculum, instructional activities, or tasks in which the student engages are also recorded (Berliner, 1990).

The amount of time a student needs to learn a specific task to a satisfactory level may differ between students due to their individual differences in ability (Gettinger, 1984). How much time students are willing to invest in time on task is impacted by self-efficacy beliefs which will then influence a student's level of persistence (Multon, Brown, & Lent, 1991). Students will continue to invest sufficient time in learning (or not) if their own metacognitive judgements of how effective their learning has been continuing to be satisfactory (Metcalf, 2009).

Constructivism as a theory of learning posits that learning is a set of constructive processes in which the individual student (alone or socially) builds, activates, elaborates, and organizes knowledge structures (Seidel & Shavelson, 2007). From this conception of learning, it follows that student time should be spent maximizing opportunities to engage in activities that

promote higher order learning. In other words, constructivism values maximizing time on tasks by students engaging in meaningful and purposeful activities.

Performance Assessments and Constructivism. Constructivist teaching practices also emphasize the need to integrate the processes of active instruction (discussed above) and authentic assessment, in this case as two separate processes, that complement each other in a reciprocal nature to build student knowledge in the learning process (Bekyrodlu, 2008).

Assessment methods that can identify students' current understanding and provide regular feedback during instruction are critical to the learning process (Boston, 2002). The ORCA, used in both the previous and current study, situates students in an assessment environment that requires students to construct meaning from their online research experience through a guided performance. The ORCA environment scaffolds the online learning experiences for students as they encounter guiding questions and graphical organizers along with specific tasks chunked throughout the process. Theory underlying the use of performance assessments is included in the following section.

Performance Assessment Theory

Assessment in education is defined as the measurement of the outcome as to whether or not a student has achieved the curricular goals (Choppin, 1985). During the early 1990's, as the Constructivist movement garnered popularity and more research attention, performance assessments, as a concept based in the alternative assessment movement, first became part of the assessment discussion (Wiggins, 1998). Later in the 1990's, theory and practice of assessing learning underwent a paradigm shift, based on the realization that educational considerations, not psychometric or political ones, should be driving assessment reform (Biggs, 1995). Performance assessments initially were just one type of alternative assessment that also included assessments

such as authentic assessment and portfolio assessment (Reeves & Okey, 1996). Consequently, implementation of performance assessments that required thinking skills and that were consistent with these new cognitive theories of learning emerged as the alternative assessment movement in schools expanded across the United States (Macroff, 1991). The movement was driven by the expectation that students not only apply knowledge but also use higher order thinking skills, make analysis and synthesis, evaluate knowledge, and solve daily life problems (Bekyrodlu, 2008). Early concerns regarding validity slowed the adoption and use of performance assessments. However, later developments in the philosophy of validity, which highlighted the importance of investigating the consequences of assessment, is now used to provide theoretical justification for their use for learning measurement (Moss, 1992).

Performance based assessments, now commonly known as performance based assessment (PBA), are one type of modern assessment that is being used increasingly in classrooms (Frey, Schmitt, & Allen, 2012). A performance based assessment is one in which complex, authentic tasks are completed, often involving a real-world situation in which students are asked to apply knowledge and skills (Lai, 2011). Because traditional assessments often are removed from real classroom goals, test abstract skills in isolation, and ignore student prior knowledge (Zollman & Jones, 1994), recent trends in classroom assessment shown a move to embrace PBAs. PBAs are being used in the classroom to help teachers make instructional decisions at the unit level. They are also being used as formative assessment tools to help make day-by-day decisions to differentiate instruction for individual students (McMillan, 1997). PBAs along with other traditional assessments of student learning have been used to determine student progress in the knowledge construction process (Bekyrodlu, 2008).

Advocates of non-traditional assessments suggest that the wider use of PBAs and related instructional approaches have the potential to transform the classroom learning experience (Rothman, 1995). PBAs typically represent a set of strategies for the application by students of work habits, knowledge, and skills through a series of tasks that are meaningful and engaging to students (Hibbard, 1996). Typically, PBAs include three key features of performance assessment: (1) students construct, rather than select, responses; (2) assessment formats allow teachers to observe student behavior on tasks reflecting real-world requirements; and (3) scoring reveals patterns in students' learning and thinking (Fuchs, 1995). This type of assessment can provide classroom teachers with important information to make better instructional decisions based upon how a student understands and applies knowledge. Under some circumstances, performance based assessments can be a catalyst for specific instructional behavior and procedure changes in the classroom more easily than general teaching paradigms (Firestone, Mayrowetz, & Fairman, 1998). As Wiggins (1993) discusses, the aim of assessment is primarily to educate students and improve student performance, not merely to audit the student's current understanding. Assessment, according to Wiggins, is of little value "unless it is educative—that is, instructive to students, teachers, and school clients and overseers." Darling-Hammond (1994) argues that it is necessary to have policy and practice in place to ensure the assessment are used to give teachers practical information on student learning and to provide opportunities for school communities to engage in self-reflection (Darling-Hammond, 1994).

The ORCA sought to avoid many issues associated with assessment of online learning by using performance based assessments within a virtual world simulation. The assessments presented students with a problem in science and then asked them to conduct online research to learn about the problem and to communicate what they have learned in a simulation. In a study

by de Klerk, Veldkamp, and Eggen (2015), simulations were found to have three main advantages over other traditional forms of assessment. First, greater student engagement is found within a simulation than in a more restricted context, increasing a student's flow (Csikszentmihalyi & Csikszentmihalyi 1991). This helps to avoid possible test anxiety and therefore generates a more genuine student performance. In addition, greater emphasis is placed on knowledge application for learning, versus knowledge replication typically found in paper based assessments, in richly contextualized and simulated contexts. Finally, simulations allow researchers to capture performance and process data from students that are typically richer than basic summative assessment data.

Related Prior Research

In addition to being framed by theoretical perspectives in disciplinary theory and new literacies theory along with foundational concepts of constructivism and performance assessment, this study was also informed by three areas of research that included the following: 1) scientific literacy, 2) digital technology tools and practices commonly found in modern classrooms and learning spaces, and 3) previous assessment, including performance based assessments related to measuring online research.

Scientific Literacy

As the importance of STEM education has gained increased attention over the last five years in United States public schools (Executive Office of the President of the United States, 2013; National Science and Technology Council, 2013), particularly with the federal government's focus and financial support in these areas, so too has research into the specific disciplinary literacy of science, including the ability to perform scientific research online (Holden, 2013; NGSS Lead States, 2013). Thus, the previous study and this current study focus

specifically on the science discipline. Teaching STEM concepts without also teaching the scientific literacy skills that students need is not likely to be effective (Cervetti et al., 2005). At the core of what it means to engage in science through scientific literacy is research. Research, for the purposes of this paper, is the process of persuading others of the validity of one's claims using justified, observable evidence, or logic (Erduran & Jimenez-Aleixandre, 2008). Teaching generic research literacy skills without teaching the specific skills and knowledge associated with online research is not likely to support this process or be effective (Kardash, 2000).

The Common Core State Standards (CCSS, 2010) include research as a key set of skills and practices that students will use as they advance through primary and secondary grades and beyond. In the preface to the CCSS for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects, the importance of research in the standards is made clear.

"To be ready for college, workforce training, and life in a technological society, students need the ability to gather, comprehend, evaluate, synthesize, and report on information and ideas, to conduct original research in order to answer questions or solve problems, and to analyze and create a high volume and extensive range of print and non-print texts in media forms old and new. The need to conduct research and to produce and consume media is embedded into every aspect of today's curriculum. In like fashion, research and media skills and understandings are embedded throughout the Standards rather than treated in a separate section." (CCSS, 2010)

Due to the integrative nature of the CCSS, the writing standards have their own "Research to Build and Present Knowledge" strand. These include the specific skills needed to perform research and are pervasive throughout the standards.

As mentioned previously, the NGSS have also recently been released in addition to the CCSS and it includes research practices as part of the specific content and abilities students should be aware of and use in the study of science. The NGSS were designed to specifically align with the standards and practices in the CCSS including research skills for learning (Bybee,

2014). The eighth core NGSS Science and Engineering Practices is “obtaining evaluating, and communicating information” (National Research Council, 2011). Practices, in the context of science learning, are different from skills because they include both knowledge and skills that are essential for helping students develop a deeper understanding of how knowledge in science is formed and to make this concept knowledge more meaningful (National Research Council, 2011).

It could be assumed that these sets of standards might include a standard measure for assessing a student’s abilities to perform online research in science. It would follow that before teaching students how to perform online research, we need to better understand students’ current practices in this area to provide direction for classroom instruction. Work is well underway for assessing the CCSS (USDOE, 2010) but from a summative high stakes approach. This does little for information day-to-day classroom instruction. The NGSS are very new and the changes for their adoption are barely underway. New assessments must be developed as states and districts begin the process of implementing the NGSS and changing their science education curriculum and instruction (National Research Council, 2011).

Science engagement by students can be thought of from two perspectives: a goal of personal engagement with science and a societal goal for engagement (Forzani, 2016). Science can affect people’s personal lives when they need to engage with basic scientific information online in order to understand issues of personal importance. Medical decisions for themselves or loved ones (Stadtler & Bromme, 2014; Hansen, Derry, Resnick, & Richardson, 2003), healthy food choices (Lohse, 2013), and facts about science-related controversial political issues (Zeidler, 2009) are affected by one’s personal engagement with science. Science can also affect society’s direction and decision making regarding large ill-defined problems in the world

currently. These include global climate change, water conservation and shortages, harmful diseases and antibiotic resistant bacteria, famine, terrorism, and resource rich lifestyles of a growing global middle class (Birch, Looi, & Stuart, 2013). Science in the twenty-first century represents globalized information and knowledge which benefits from exploitation of new technologies such as the Internet. This helps enable the flow of information and knowledge to solve these problems (Renn, 2012). Given the urgency of these issues and the important role science plays, both personally and societally, teachers have become increasingly focused on preparing students by facilitating experiences with these skills in order to engage with these scientific issues (Forzani, 2016).

Technology for Learning

Over the last fifteen years we have seen the number of computers in U.S. classrooms steadily increase. In 2000, there were 6.6 students in U.S. schools per instructional computer. In 2005, there were 3.8 students in U.S. schools per instructional computer. In 2008, there were 3.1 students in U.S. schools per instructional computer (National Center for Educational Statistics, 2008). Almost 75% of U.S. public high school students reported that they regularly use a smartphone, tablet, or laptop in their classroom on a regular basis (Barnes, 2012). However, growing evidence indicates that teachers have been extremely slow adopting new methods of instruction despite this influx of access to new digital technology in their classrooms (Buabeng-Andoh, 2012). The constructivist, student centered, personalized, inquiry-based instruction envisioned by those who have been advocates for computers in the classroom (Siemens, 2004; Jonassen, Howland, Moore, & Marra, 2002; Hirumi, 2001) remains the exception in U.S. classrooms not the rule.

Cuban (2013) argues that the introduction of computers into schools was supposed to improve academic achievement and alter how teachers taught, yet neither has occurred. Cuban believes, that we need a research base to show benefits based on new assessments that clearly demonstrate the value of learning with technology (Cuban, 2013). A National Center for Education Statistics survey of 3,159 teachers found that when teachers did allow students to use technology, it was most often to prepare written text (61% reported "sometimes" or "often") conduct Internet research (66%), or learn/practice basic skills (69%). More rare were teachers who reported students sometimes or often using technology to conduct experiments (25%), create art or music (25%), design, produce, and communicate a product (13%), or contributing to a blog or wiki (9%) (Gray, Thomas, & Lewis, 2010). The Internet research that was reported (66% of the time) was defined in the survey as Internet searching or using reference materials on CD-ROM. From this evidence, "most teachers have 'domesticated' innovative technologies by incorporating them into their existing repertoire of teacher-directed practices," (Cuban, 2013).

Why are we not seeing transformative teaching practices in the classroom? The high-stakes testing system currently being used in the United States isn't supporting the transition to student centered, technology-driven instruction. Telling teachers that classroom achievement will be measured solely by achievement on standardized tests will not change behavior (Herold, 2015). Many teachers still lack any understanding of how technology can be used. Others suffer from a level of confidence to try these new education technology tools in their classrooms. If they do not understand and believe that they can successfully use technology to meet their students' learning goals, they will not make an attempt (Ertmer & Ottenbreit-Leftwich, 2010)

Beyond teacher comfort and knowledge regarding educational technology tools, the greater challenge is in expanding teachers' knowledge with new student centered instructional

practices. On top of that, teachers' "pedagogical beliefs" are increasingly believed to play a central role in their willingness to use technology (Ertmer & Ottenbreit-Leftwich, 2010). If teachers are to enhance student achievement through the integration of educational technology they need both the technical skills and confidence as well as a command of the appropriate pedagogical models and instructional strategies.

Studies of One-to-One Initiatives. Previous studies of one-to-one initiatives over the past decade have investigated a variety of student outcomes (Argueta, et. al, 2011; Bebell & O'Dwyer, 2010; Zucker & Light, 2009). However, these studies have limited their ability to inform us about learning gains. In general, these studies suffer from three types of design weaknesses. First, some studies focus almost entirely on student self-reports, or teacher reports, to measure the added value of student access to technology (Berry & Wintle, 2009; Lowther, Strahl, Inan, & Bates, 2007). These studies are inherently subject to social desirability response error and bias in general (Adams, Matthews, Ebbeling, Moore, Cunningham, Fulton, & Hebert, 2005).

Second, one-to-one studies have often used indirect measures of learning such as: teaching practices (e.g. Cavanaugh, Dawson, White, Valdes, Ritzhaupt & Payne, 2007), teachers' and student roles in classrooms (e.g., Lowther, et. al, 2007), or motivation (e.g., Silvernail & Lane, 2004) instead of direct measures of student learning to evaluate the effects of laptop use. While these variables may be related to learning outcomes, they are not direct demonstrations of student learning. It is true that some research uses direct measures of student learning using results on state assessments. However, these assessments, typically conducted with paper and pencil, show generally mixed results (see Bebell & Kay, 2010; Lowther et al., 2007; Silvernail & Gritter, 2007).

Third, outcome measures in these studies are not especially sensitive to the development of online learning skills in classrooms because different technologies and skills are required for online learning that are not assessed with traditional state assessments (Silvernail & Gritter, 2007). This problem is exacerbated in the most common areas in which state test scores are reported in one-to-one investigations, reading and writing (Leu et al., 2015). Research has shown that skills for offline learning do not typically correspond with online learning skills. Unique skills appear to be required when reading and writing online (Afflerbach & Cho, 2010; Coiro & Dobler, 2007). For example, Afflerbach and Cho (2010), reviewed 46 studies that focused on reading strategies used during Internet searching. Their analysis showed evidence of strategies that appear to have no counterpart in traditional student learning specifically in offline reading (p. 217).

The only study to date, that has systematically studied the effect of one-to-one classrooms on the development of online learning skills is the Kennedy et al. (2016) study replicated in this study. Specifically, that study evaluated students' ability to conduct online research and learn in ways that might be sensitive to the reading and writing skills required by online information: selecting useful keywords for search engine use; reading and evaluating search engine results; critically evaluating the source reliability of information at a website; or communicating effectively with online communication tools.

Student Centered Learning and Instruction with Technology. Student centered learning evolved as a result of shifting beliefs and assumptions about the role of the individual in learning. Hannifin & Land (1997) state that, “modern instructional designers have been influenced heavily by constructivists who assert that understanding transcends the encoding of literal information and is uniquely constructed.” Computer enhanced and enabled constructivist

learning environments can promote student engagement through student centered learning activities (Hannafin, 1992). Technology-enhanced, student centered learning environments create contexts within which knowledge and skill are authentically anchored, and provide a range of tools and resources with which to navigate and manipulate (Hannafin, Hall, Land, & Hill, 1994). In effect, instructional models based on a student centered learning paradigm allows students to construct personal meaning. By relating new knowledge to existing conceptions in which technology promotes access to resources and tools, students facilitate the construction of new understandings (Hannifin & Land, 1997).

Student centered learning does not represent a single model or practice but rather draws on a variety of concepts in education which include instructional practices that engage students in deep learning with the goal of helping learners self-actualize. Student centered learning currently and typically is comprised of four main tenets. Student centered learning is personalized in which students engage in different ways, in different places, at their own pace, using tasks based on formative assessments that reflect existing skills and knowledge, and target the student's needs, interests, and goals. Student centered learning is competency-based where students move to each new learning objective when they have demonstrated mastery of previous and current objectives. Student centered learning happens anytime, anywhere. Learning is not restricted to the classroom but situated in any varying contexts supported by anytime, anywhere access to online tools and information. Student centered learning provides students with ownership over their learning by incorporating their interests and skills into the learning process (Nellie Mae Education Foundation, 2015).

Certain types of instructional practices are associated with a constructivist approach to learning. The use of technology for learning is one such instructional practice. The best

instructional technology practices are typically defined as those that promote student centered learning (Bigatel, 2004; Coppola, 2004; Moersch, 2002). Student centered learning emphasizes instructional practices that include authentic experiences, encourages active learning, and results in the creation of new products (Hickey, Moore, & Pellegrino, 2001). Research indicates that teachers who readily integrate technology into their instruction are more likely to possess constructivist teaching styles (Judson, 2006). Teachers' reasons for using technology in the classroom typically align with their beliefs, including how technology enables them to meet both professional and student needs (Ryba & Brown, 2000).

Recent studies have shown that a technology-rich, student centered learning approach can support student achievement in a variety of ways. The American Institutes for Research (2014) found in a study of student centered learning and its impact on math instruction significant results in both higher levels of student engagement and interest as well as on the problem-solving component of the PISA assessment. These results indicate that the benefits to students of having an effective math teacher are even greater when the teacher implements a student centered approaches to instruction using technology. In a study by the Education Development Center (2015), researchers looked at the technology use by students (specifically a blended learning environment using laptops and an online learning management system) in a student centered learning environment and how it impacted engagement, skills, and achievement of traditionally underserved students. Results, using the TerraNova exam which assesses understanding of science theory and methods (Education Development Center, 2015), included a statistically significant increase in student achievement in science and a marginal increase in student 22st century and inquiry skills (problem solving, communication and interpersonal interaction). A subgroup analysis of underserved students revealed similarly positive results. Additional results

include students and teachers overwhelmingly reporting positive impacts on learning as a result of the study's instructional approach.

Using technology, specifically laptops in a one-to-one environment, for school related tasks has been shown to increase student engagement (Dunleavy & Heinecke, 2007). Student engagement is related to time on task where an engaged student spends more time on task overall (Warschauer, 2005). Using time on task to measure a specific instructional activity (e.g. online research) has been demonstrated to can account for at least some of the variance observed in education instruction research regarding students learning content (Pelz, 2010). Ultimately, this means that, regardless of what other activities are taking place in the classroom, the more time students spend engaged in the activity, the more of that activity they learn.

Previous Assessments of Online Research and Learning

Currently, we have few assessments of online research and learning. Without data as to how students are performing in this important area, teachers and other school leaders have only theory and at times student self-report data to plan related instruction. Valid and reliable assessments of online research and learning that are also practical for teachers to implement in and out of the classroom are crucial if teachers are to effectively prepare students for college, career, and life in the 21st century.

Not until recently has attention been focused on developing new assessments of online research and learning so that we might begin to better understand student performance in this important new area. International work has been taking place under the leadership of the Organisation for Economic Co-operation and Development (OECD) and the International Association for the Evaluation of Educational Achievement (IEA). Three large-scale projects have provided important initial direction: 1) the Digital Reading Assessment (OECD, 2011) of

the Programme for International Student Assessment, or PISA; 2) the Problem Solving in Technology-rich Environments portion of the Program for the International Assessment of Adult Competencies, or PIAAC (Rouet, et al, 2009); and IEA's International Computer and Information Literacy Study (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2013).

Unfortunately, each has made decisions that may have limited their ability to fully assess the essential qualities of online research and learning. The limitations appear in two areas: 1) the use of separate and disconnected tasks to measure the connected sequence that defines online learning; and 2) the use of assessment contexts that often restricted interaction possibilities.

Using Separate and Disconnected Tasks to Measure a Connected Sequence of Learning Tasks. One limitation of the PISA and PIAAC assessments is that often they represented the nature of the online research or problem solving process as a set of separate tasks. Rather than evaluating the connected nature of the online research process in its entirety, unrelated elements were evaluated separately. This compromised an essential aspect of online research and learning, where performance on initial elements of the research task affects later elements of the overall larger task. If one is unable to locate useful information with a search engine, for example, it may not be possible to learn. Indeed, in several assessments, using a search engine to locate information was not even evaluated. In addition, if one is unable to summarize useful information from search results, it may not be possible to communicate arguments in support of a position taken without including all located text.

Restricting the Response Space by Limiting Interaction Possibilities. A second limitation characterized the PISA Digital Reading Assessment, the PIAAC assessment, and the International Computer and Information Literacy Study: the use of restricted contexts that limited interaction possibilities. Problems in these assessments were typically posed within a

single location rather than within the more extensive and connected set of sites that defines online information. Typically, they also lacked fully functional online tools such as a search engine, email, text messaging, wiki, blog, or social network.

By restricting the assessment context, these particular assessments failed to replicate the more complex and connected demands of online research and learning. It is likely that they resulted in digital reading and problem solving assessments that shared many commonalities with traditional, and thus static, offline reading. Correlations between students' scores on these assessments and a measure of offline reading in the PISA study suggest this possibility (see OECD, 2013).

Using Performance Based Assessments in a Virtual World Simulation. The third study, IEA's International Computer and Information Literacy Study (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2013) used separated tasks but within a continuous narrative containing somewhat limited interaction possibilities. The assessment space did, however, use a simulation. According to de Klerk, Veldkamp, and Eggen (2015), simulations have at least three advantages over other forms of assessment. First, engagement is greater within a simulation than in a more restricted context, increasing flow (Csikszentmihalyi & Csikszentmihalyi 1991), avoiding test anxiety, and generating more typical performance. Second, greater emphasis is placed on knowledge application for learning in richly contextualized and simulated contexts rather than simply replicating knowledge such as takes place in paper based assessments. Finally, simulations allow us to capture richer data on student performance, including process data.

The extent to which CCSS assessments will focus on online literacies, if at all, remains unclear. The political climate in the United States, as of 2016 in the midst of a presidential election, has those who support the CCSS on the defensive. Full adoption of the CCSS has been

slowed and some U.S. states are removing the CCSS as a requirement (Marshall, 2016). Additionally, states are rejecting the United States federally funded CCSS assessments (SBAC and PARCC) in favor of state created tests or the SAT which does not include an assessment of online research (Gewertz, 2016). The use of PBAs for CCSS is also not clear. However, some indications may suggest that their use has been severely limited by individual states (Jacobs, 2012). What is clear is that to the extent PBAs in New Literacies, and specifically online research, are included in CCSS assessments, teachers are likely to be better informed about instruction than assessment.

This study sought to avoid many of the issues appearing in previous assessments by using complete, PBAs of online research and learning within a virtual world simulation, containing a continuous online research task in science. It used a virtual world simulation in which we evaluated students' ability to conduct online research and learn. The simulation included student avatars, text messaging, email, wikis, a search engine, and over 500 web pages imported from the Internet. The assessments presented students with a problem in science and then asked them to conduct online research. It concluded by asking them to write a short report in a wiki or an email message to summarize what they learned.

Research Questions

This study addressed four research questions:

1. Did significant differences appear between students in the two states on scores for any of the covariates: SES, prior domain knowledge scores, offline reading, and teacher experience?

2. After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning for students in the state with a one-to-one computer policy?
3. After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score for any of the separate component scores of online research and learning (locate, evaluate, synthesize, communicate) for students in the state with a one-to-one computer policy?
4. Is there a relationship between teacher practices used for student online research and learning success and ORCA performance as measured by teacher and student responses on the Internet use surveys?

This study first asks if significant differences appear between students in the two states on scores for any of the covariates. I hypothesize that based on the results from the previous year 3 study, SES, prior knowledge in science, offline reading scores, and teacher experience will be significantly greater for students in Connecticut. The second question this study examines is if there is evidence of a higher mean score on an assessment of online research and learning for students in the state with a one-to-one computer policy after conditioning on differences for the covariates. I hypothesize that based on the results from the previous year 3 study and empirical evidence of the impact on online research and learning, it is hypothesized that ORCA total online research and learning scores will be significantly higher, on average, in the state that has a one-to-one laptop requirement after relevant covariates have been conditioned. The third question this study is similar to research question 2 where it examines if there is evidence of a higher mean score for any of the separate component scores of online research and learning after conditioning on differences in the scores for the covariates but uses individual total scores for

locate, evaluate, synthesize, communicate instead of the total ORCA score. I hypothesize that based on the results from the previous year 3 study and empirical evidence of the impact on online research and learning, it is hypothesized that each ORCA total component score (Locate, Evaluate, Synthesize, and Communicate) will be significantly higher, on average, in the state that has a one-to-one laptop requirement after relevant covariates have been conditioned. The final question this study used the student and teacher Internet use surveys to examine if there is a relationship between teacher practices used for student online research and learning success and ORCA performance. I hypothesize that based on peer-reviewed literature has demonstrated a strong relationship between teacher practices and classroom learning. Specifically, I hypothesized that teachers who assign Internet related tasks at a higher rate will correspond with higher student ORCA scores.

Chapter Summary

This chapter reviewed the literature in several key areas of online research and learning in science. Theoretical perspectives included disciplinary literacy and scientific literacy, New Literacies Theory and the new literacies of online research and comprehension; constructivist learning theory, and performance assessment theory. This chapter also included a review of prior research on scientific literacy, technology for learning, and previous assessments of online research and learning. The review sought to establish a context for the research conducted in this study and the previous replicated study. The review provides a foundation for the intersection of these areas as they are implemented through the design of the ORCA and the resulting student experiences. Four research questions were examined in this study, which shed light on some of these areas as they are used for student learning.

CHAPTER 3

PROCEDURES AND METHODS

Introduction

There were two purposes to this study: (1) re-examine the results of the findings of a study of one-to-one laptop use by Kennedy, Rhodes & Leu (2016) through a replication study using a larger, more reliable, and different set of data, (2) extend the understanding of the findings through the investigation of results from a more comprehensive set of teacher and student Internet use surveys.

This study examined four research questions:

1. Did significant differences appear between students in the two states on scores for any of the covariates: SES, prior domain knowledge scores, offline reading, and teacher experience?
2. After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning for students in the state with a one-to-one computer policy?
3. After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score for any of the separate component scores of online research and learning (locate, evaluate, synthesize, communicate) for students in the state with a one-to-one computer policy?
4. Is there a relationship between teacher practices used for student online research and learning success and ORCA performance as measured by teacher and student responses on Internet use surveys?

The quantitative approach to this study examined middle school students' online research capabilities within the area of science. Specifically, this study examined how well seventh grade students perform research online in science in one state with a one-to-one laptop policy and a second state without such a policy and to identify the variables that contribute most to these differences. The first three research questions replicate the questions studied in the initial study (Kennedy et al., 2016). The purpose of the fourth question was to examine if a relationship between teacher practices and classroom learning existed. Specifically, if teachers who assign Internet related tasks at a higher frequency will correspond with students with higher ORCA scores. The data used in all four research questions come from year 4 of the ORCA Project.

Substantial differences exist between the ORCA instrument and the teacher and student Internet use surveys used in the initial study for ORCA year 3 data and this study using ORCA year 4 data. The changes were made based on data and feedback from the work done on year 3 data were discussed in the initial study (Kennedy et al., 2016). The specific differences are discussed below.

Participants

Participants included seventh grade students who participated in Year 4 of the five-year ORCA Project study examining students' online research and learning ability. This study included all students who took the ORCA-Simulated format as part of The ORCA Project (Leu, Kulikowich, Sedransk, & Coiro, 2009-2014). A total of 1,628 students from two different states in the Northeast participated in this study. This total included 851 students from Connecticut and 777 students from Maine. The total included 803 male students and 825 female students. The students were enrolled in 17 school districts in Connecticut and 23 school districts in Maine.

Students attended only one of the schools in each school district. See Table 3.1 below for a summary of demographic information.

Schools and their school districts were identified based on a sampling plan that stratified districts by SES, geographic area (urban, suburban, rural), and mean reading comprehension score on standardized state tests. In each school that was selected for this plan, principals were asked to identify two English/Language Arts teachers whose heterogeneous classes most represented the student population of the school. This approach was useful to maintain good relationships with school partners. Principals were not aware that their state would be compared with another state and we have no reason to believe that any systematic bias occurred in the selection of teachers in one state over the other.

Each English/Language Arts teacher was then asked to select two of their classes, which also most represented the student population to participate in the study. All students in each class were invited to participate in the study. Only those students who returned a parental permission form and who also signed a student assent form were allowed to participate in the study. Each class included approximately 20 students.

Connecticut is a state that historically has not provided a systemic one-to-one laptop program for middle school students. Maine has provided all middle school grade 7 students access to a one-to-one laptop program starting in 2002 (Waters, 2009) as part of the Maine Learning Technology Initiative (MLTI). These two states were selected to ensure a sample that included one state that has a laptop program and one that does not.

Table 3.1

Demographic Data for Connecticut and Maine

	Connecticut	Maine

Median Household Income 2014*	\$70,048	\$49,462
Population in 2014**	3,596,677	1,330,089
Ethnic Makeup***	81.6% white 11.3% Black or African American .5% American Indian and Alaskan Native 4.3% Asian .1% Native Hawaiian or Other Pacific Islander 14.7% Hispanic or Latino 2.1% two or more races	95.2% white 1.4% Black or African American .7% American Indian and Native Alaskan 1.1% Asian <.5% Native Hawaiian or Other Pacific Islander 1.4% Hispanic or Latino 1.6% two or more races
Mean Scaled Reading Score for NAEP 2013****	274	269

Notes. * Engebret, 2014; ** List of U.S. states by population, 2014

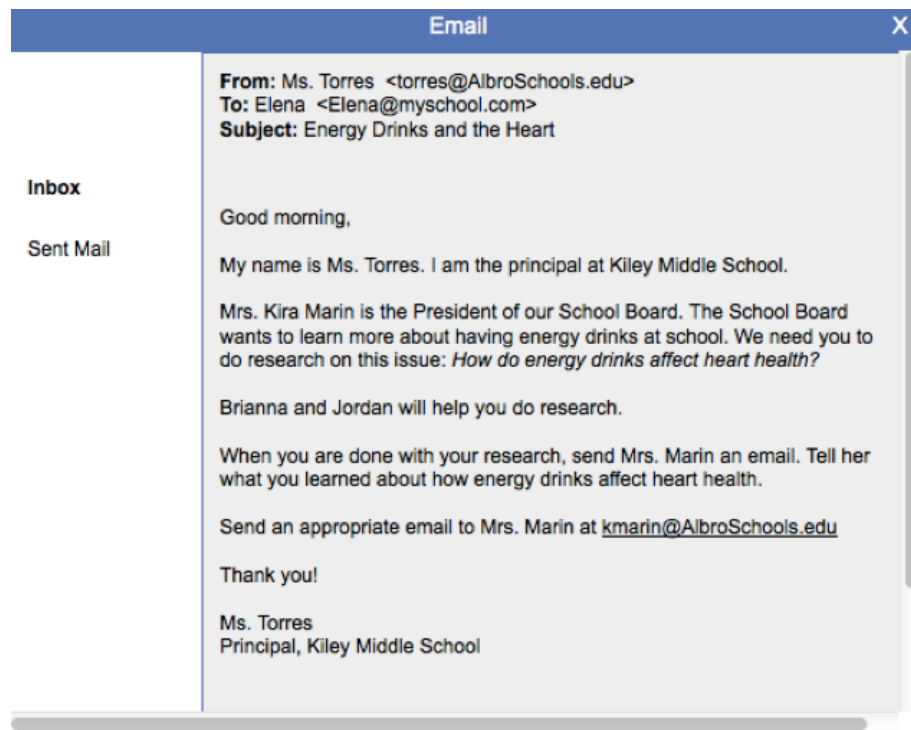
*** U.S. Department of Commerce, 2015; **** U.S. Department of Education, 2013

Instrumentation

The Online Research and Comprehension Assessments (ORCAs) were designed to assess learning during an online research task. More specifically, the ORCA was designed to assess how students are able to work online to locate information, evaluate information, synthesize information from multiple sources, and communicate what they had learned in either an email message or a wiki post (see Figure 3.1 below). Multiple versions of the ORCA were created. All data used in this study came from student assessments using the ORCA-II. The ORCA-II assessment was designed and developed from a five-year federal grant to assess middle school students' ability to conduct research online in science by the New Literacies Research Lab at the University of Connecticut (Leu et al., 2009-2014). The original ORCA (or ORCA-I) was designed for use during Year 3 of the ORCA Project grant (Leu et al., 2009-2014) and was used in the study being replicated. Prior to creation of the original ORCA, two rounds of test

assessments were conducted. The first round included pre-pilot testing in two school districts in Connecticut. The second round included pilot testing in 41 districts in Connecticut and Maine with a revised set of assessments (ORCA-I). The ORCA-IIs were a further revised set of assessments based off of the ORCA-I version and were used for data collection in year 4. (See Leu, Coiro, Kulikowich, & Cui, 2013 and Leu, et al., 2014 for discussions.)

Figure 3.1. Email Communication Tool used in the ORCA



Previous work suggested that specific elements were especially important to consider when designing an assessment for online research and learning when taking into account the student population (grade 7) and the interplay between the four skill areas (locate, evaluate, synthesize, communicate) (Leu et al., 2014). A performance based design was selected for multiple reasons. Students find PBAs more engaging (Hancock, 2007) and they are more likely to optimize problem-solving persistence. PBAs are also better at evaluating complex tasks such as writing, critical evaluation, and the interrelations between research tasks not always obtained

when separate items are used and assessed (Frederiksen, 1984). With the current advances in digital technologies, assessment designers have enhanced abilities to create environments that allow for authentic student practice using tools like email, wikis, and search engines to demonstrate student skill (e.g., Quellmalz, Davenport, Timms, DeBoer, Jordan, Huang, & Buckley, 2013).

In the ORCA-II, students participated in an online research task in which they worked with a fictitious school board president to research a science problem and ultimately provide a response via email or wiki. Avatars were used throughout the ORCA to resemble actual online research activities, which often occurs in a collaborative environment (Engestrom & Sannino, 2010). Students worked within a social network environment and responded with answers into a comment box as they were provided with prompts. Students conducted research using a closed Internet-like simulated system and a search engine (see Figure 3.2 below) called “Gloogle.” Students also were encouraged to take notes into a provided digital notepad as they read different articles on different websites.

Figure 3.2. Gloogle Search Tool used to locate information in the ORCA-Simulated



Included in the ORCA-II activity was a Student Internet Use Survey (SIUS). Students answered multiple-choice questions regarding their individual use of technology and the Internet. Specifically, students were asked about computer usage at home, where and how they used the Internet both in and out of school, and their motivations and effectiveness with using the Internet. The SIUS is included in Appendix A. Also, included as part of the ORCA-II activity was a Teacher Internet Use Survey (TIUS). Teachers answered multiple-choice questions regarding their individual use of technology and the Internet. Specifically, teachers were asked about their teaching experience and classroom situation, use of the Internet in the classroom, personal use of the Internet, effectiveness of their students to use the Internet, and strategies and barriers for effective use of the Internet to increase learning through classroom integration. The TIUS is included in Appendix B.

Prior to engaging in each day of the ORCAs, students were asked to complete a short multiple-choice assessment designed to measure their prior knowledge on the science topic that was the focus of their assigned ORCA. In addition to Prior Knowledge, students completed a measure of their offline reading ability. Assessment of their offline reading ability (ORM) took place in-between the administration of their two ORCA assessments. ORCA facilitators distributed the ORM assessments to each school teacher on the first day of testing. Completed ORM assessments were collected on the second day once ORCA testing was complete. The ORM assessments were completed by students using a provided prompt, paper, and pencil (see Appendix C for the ORM assessments).

Versions

Cognitive Labs – Years 1-2. The initial two years of the ORCA Project were used to design and build initial assessments for online research and learning tasks. Cognitive labs were conducted for small groups of students in Connecticut. Feedback from the cognitive labs were incorporated into the development of the initial full versions of ORCA. From the labs, a total of 24 actual assessments across three unique formats were originally created. The formats included ORCA-Open (students used the live World Wide Web), ORCA-Simulated (students used a simulated and closed Web-like environment), and ORCA-Multiple Choice (students used a simulated Web-like environment but only respond to multiple choice questions). For each of the three formats, eight middle school science topics were assigned. Students' prior knowledge was measured using a verbal protocol analysis and idea unit analysis that has demonstrated past reliability (Wolfe & Goldman, 2005).

ORCA I - Year 3. The third year of the ORCA Project was the pilot year. During this third year, all 24 of the ORCAs (8 for each of the 3 formats) were used with approximately 1,200 seventh

grader students in Maine and Connecticut. The ORCA-Multiple Choice assessments were scored automatically. The ORCA-Simulated assessments were scored by a team of trained UConn undergraduate students. The ORCA-Open assessments occurred within the actual World Wide Web thus these activities occurred outside of the ORCA data capture tool. All ORCA-Open activities were recorded as videos using screen capture technology. The OCRA-Open provided students with a true authentic online experience but was not ideal as an assessment for numerous reasons. The ORCA-Open format was not a stable and controllable environment. For example, a student assigned to the “same” assessment (out of 24) as another student would likely not be experiencing the same tasks and environment since each student’s experiences, including the websites they found in the search engine, could be very different. In addition, scoring the ORCA-Open data by viewing the captured videos was extremely time-consuming for scorers. It was the opinion of the test administrators that classroom teachers were not likely to commit to the time required to score each student’s results if viewing each individual video was necessary. It was decided that development of the ORCA-Open for the fourth year of the project would be discontinued.

ORCA II - Year 4. The fourth year of the ORCA Project was the validation year. The ORCA assessments used in the validation year were modified from the pilot year based on numerous factors most importantly the psychometric data on reliability and validity from the pilot year. In addition to discontinuing the ORCA-Open, other revisions were made including the dropping of many of the 24 assessments (3 formats by 8 topics) used in the pilot year. A total of eight ORCAs were used in the validation year. These consisted of ORCAs in two formats: ORCA-Simulated and ORCA-Multiple Choice. Four assessment topics were assigned to each of the two formats. Minor changes were made to the wording of items in the assessments for clarity and to

some of the answer choices in the multiple-choice format. All revisions resulted in the current version of the ORCAs (ORCA-II) which are currently freely available to all schools and educational organizations to use.

Structure

Assessments took place within a virtual online world containing a social network, email, an extensive collection of web pages, a search engine, text messaging, and a wiki. Brianna, a fictional student avatar, first presented the research problem (e.g. “Does third-hand smoke harm your health?”) through text messaging. Brianna then directed each student to an email message in his/her inbox or to a section on a science classroom’s wiki. Information in the email or on the wiki provided additional context for answering the research problem and for writing and communicating a short written report. Once a student finished viewing a short email message from a virtual school board president, she/she was then guided through the remainder of the task by the avatar.

Each research activity followed a common structure which contained tasks designed to estimate a student’s ability in four areas important to conducting online research and learning: locating, evaluating, synthesizing, and communicating online information. Each area contained four tasks including three process items and one product item. Each was evaluated on a binary basis; one score point was given for each correct response and no score point was given for an incorrect response. Careful consideration was given for an alternative scoring rubric, one that allowed for partial credit to items. After looking at items, we did not find a substantial number of item responses where partial credit could have been provided. While a scoring rubric allowing for partial credit for each item may have had some advantages in capturing gradations in student performance, it would have been more difficult for raters to reach consensus regarding

the appropriate categorization of student responses. Ultimately a binary scoring approach was chosen, largely due to its promise of increased reliability.

Skill Areas

A total of 16 score points were possible for each online research activity for ORCA-Simulated or ORCA-Multiple Choice. Table 3.2 lists each of the score points in every assessment. A complete ORCA consisted of two online research tasks or 32 possible score points in the pilot study year. In the current study of data from the validation year, ORCA data consisted of only one online research task or 16 possible score points from an ORCA-Simulated assessment. Leu et al. (2016) included the following skill area descriptions and tables found below.

Table 3.2

ORCA Items by Skill Area

<i>Locate</i>
Can the student locate the correct email message in an inbox or the correct section of a wiki?
Can the student use appropriate key words in a search engine?
Can the student locate the correct site in a set of search engine results?
Can the student identify correct website addresses in two different search tasks?
<i>Evaluate</i>
Can the student identify the author of a website?
Can the student evaluate an author's level of expertise?
Can the student identify an author's point of view?
Can the student evaluate the reliability of a website?
<i>Synthesize</i>
Can the student summarize an important element from one website?
Can the student summarize important elements from two websites?
Can the student summarize important elements from a second set of two websites?
Can the student summarize important elements from the websites in the research task to develop an argument?

<i>Communicate</i>
Email Task: Does the student include the correct address line in an email message?
Wiki Task: Does the student make a wiki entry in the correct location?
Email Task: Does the student include an appropriate subject line in an email message?
Wiki Task: Does the student use descriptive voice in an informational wiki?
Email Task: Does the student include an appropriate greeting in an email message to an important, unfamiliar person?
Wiki Task: Does the student include an appropriate heading for a new wiki entry?
Email Task: Does the student compose and send a well-structured, short report of their research, including sources, in an email?
Wiki Task: Does the student compose and post a well-structured, short report of their research, including sources, in a wiki?

Locate. Location is defined in the ORCA-II as a process of locating information that is relevant and useful to complete a specific research task. The purpose of the locate skill area is for a student to identify information that is useful for creating an accurate understanding in regards to answering an identified research question. Locate includes numerous sub-processes including finding the relevant location of information in an email or wiki, determining and using key words to obtain relevant search information, determining a relevant website using headings and text in a set of search engine results, and identifying useful website information from a selected site after reading the included website components.

The four locate items on the ORCA-IIs measure students' ability to locate information during an online research and learning task. Four score points make up the up total score in the locate skills area. These four score points include, 1) locate the email message in an inbox that is relevant to the research task or the relevant section of a wiki; 2) use appropriate key words in a search engine when searching for information relevant to a research task and when some

parameters are provided; 3) locate the correct website in a set of search engine results that is relevant to the search query requested by the avatars; and 4) identify the correct website addresses in two different search tasks. This final locate score point is derived. Students must identify both addresses correctly in order to receive a point for the correct score. Locate skill area tasks are separated from evaluation skill area tasks when possible to assess abilities in these two skill areas separately. In the literature and in practice, locate and evaluate are often closely tied to one another (Forzani, 2016). To address this issue, in the ORCA-IIs, students are provided with links to specific webpages they are asked to evaluate. See Table 3.3 for scoring criteria for locate skills.

Table 3.3

Scoring Criteria for the Locate Scale for Video Games and Eyesight Task

Item	Locate 1	Locate 2	Locate 3	Locate 4
Purpose of Stem	Can the student locate the correct email message in an inbox or the correct section of a wiki?	Can the student use appropriate key words in a search engine?	Can the student locate the correct site in a set of search engine results?	Can the student correctly identify and share the website addresses from two different search tasks?
Item Stem	First, go to the wiki. Then, read the section on video games. When you are done, tell me you are finished. To go to the homepage of the wiki, click here.	Please use the Internet to find another website that says video games <u>help</u> your eyes.	Please use the Internet to find another website that says video games <u>help</u> your eyes.	Second URL: Below send me the address, or link, of the website that you find.
Scoring Criteria	On the first search task, the student locates the correct email message (email)	On the first search task, student uses appropriate key words based on	On the first search task, the student selects a correct site from the search results	The student provides two correct website addresses from the two search

	<p>or wiki section (wiki) on the first click. Restricted and Unrestricted Tasks: Same criterion for both tasks.</p>	<p>information provided by Brianna. Restricted (Energy Drinks and Contacts): On the first search task, the student uses appropriate key words, entering the article's title as the search term. Unrestricted Task (Video Games and Heart Healthy Snacks): On the first search task, the student uses appropriate key words, entering both topic and claim as search terms.</p>	<p>on the first click when the correct site is not in the first position. Restricted: For the first search task, did the student select the correct, target website from search results on the first click? Unrestricted: For the first search task, did the student select one appropriate site related to the topic from search results on the first click?</p>	<p>tasks (scored on exact URL entry). Restricted: Did the student correctly provide both correct website addresses from the two search tasks? (scored on exact URL entry) Unrestricted: Did the student correctly provide two topically relevant website addresses from the two search tasks? (scored on exact URL entry).</p>
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Evaluate. Evaluate is defined in the ORCA-II as a process of evaluating information that includes the ability to read and then to evaluate the information's level of accuracy, reliability, and bias that is relevant and useful to complete a specific research task. The evaluation skill area includes a total of four score points. These four score points include, 1) identify the author of a given website, 2) evaluate the author's expertise in relation to a specified research topic, 3) determine the author's point of view and one piece of written or visual evidence that matched that point of view, and 4) evaluate the overall reliability of the website. See Table 3.4 for scoring criteria for evaluate skills.

Table 3.4

Scoring Criteria for the Critical Evaluation Scale for the Video Games and Eyesight Task

Item	Evaluate 1	Evaluate 2	Evaluate 3	Evaluate 4
Purpose of Item	Can the student identify the author of a website?	Can the student evaluate the author's level of expertise?	Can the student identify the author's point of view?	Can the student evaluate the reliability of a website?
Item Stem	Can you tell us who is the author or creator of this website, <i>“Playing Video Games May Cause Eyestrain”</i> ?	Is Troy Bedinghaus an expert on video games or eye health? How do you know?	What is the author’s point of view? What words or images does the author use to support that point of view?	Is the information at this website reliable? How do you know?
Scoring criteria	The student correctly identifies the author of the website (First, last, or first and last names accepted. Spelling variants accepted.)	The student judges the author's level of expertise AND provides an appropriate supporting detail about the author’s level of expertise (or lack thereof).	The student identifies the author's point of view AND provides one accurate and specific piece of evidence from the webpage about words or images that supports this determination of the point of view.	The student evaluates the reliability of the website (or lack thereof) AND provides one logical and accurate explanation to support their conclusion about either: author expertise, publisher trustworthiness, or research findings.

Synthesize. Synthesize is defined in the ORCA-II as a process of summarizing and integrating information relevant to a specific research task across multiple texts that is relevant and useful to complete a specific research task. The purpose of the synthesize skill area is to assess student ability to integrate relevant and important information across multiple digital (web-based) texts. The synthesize skill area includes a total of four score points. These four score points include, 1)

summarize one important element from a webpage that was provided; 2) synthesize important information from one set of two webpages (one page that was provided and one that the student had to locate herself); 3) synthesize important information from a second set of two websites, and 4) synthesize important information from the research task to develop an argument (students were allowed to use information from the critical evaluation webpage as well as the four webpages from the rest of the task). Please note, the first synthesis score point asked students to summarize information from only one website. This is done purposefully as a student's first step in the process of synthesizing across multiple texts to determine ability level in this skill area given a greater ability range. See Table 3.5 for scoring criteria for synthesize.

Table 3.5

Scoring Criteria for the Synthesize Scale for the Video Games and Eyesight Task

Item	Synthesize 1	Synthesize 2	Synthesize 3	Synthesize 4
Purpose of Stem	Can the student summarize an important element from one website?	Can the student summarize important elements from two websites?	Can the student summarize important elements from a second set of two websites?	Can the student summarize important elements from the websites used in the research task to develop an argument?
Item Stem	Summarize the ONE, MOST IMPORTANT, idea you found from Website #1 to support this claim: Video games help your eyes. Use your own words.	Below, send me a summary of what you learned from BOTH Website #1 and #2. Include important details from both websites.	Below, send me a summary of what you learned from BOTH Website #3 and Website #4. Include important details from both websites.	Now, take a position. Do video games <u>harm</u> your eyes? Send me a summary of what you think after reading all FOUR sites. Include important details from the websites that explain your thinking.

Scoring Criteria	Does the student provide a summary of one important element from the first website using their own words (at least 3) that supports the given claim ("Video Games HELP your eyes"). Can be exact same as notepad because it is the notepad.	Using notes from the notepad or information from the sites themselves, can students use their own words (at least 3) to integrate one detail from each of the first two websites that supports the given claim ("Video Games HELP your eyes")?	Using notes from the notepad or information from the sites themselves, can students use their own words (at least 3) to integrate one detail from each of the second two websites that supports the given claim ("Video games HARM your eyes")?	Student uses own words (at least 3) to provide a claim/argument and one supporting detail from each of two different websites. Student uses own words (at least 3) to provide an argument (that takes a position) AND two pieces of evidence, one detail from each of two different websites.
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Communicate. Communicate is defined in the ORCA-II as a process of reading and writing online to seek more information or to share what has been learned. The purpose of the communicate skill area is to communicate to others what the student has learned from the research process. The communicate skill area assesses student ability using either an email message or a wiki as the communications tool. The communicate skill area includes a total of four score points. These four score points include, 1) communicating information in the correct and appropriate location of a given communication tool (either the correct address line in an email message or the correct location in a wiki); 2) communicating information using a tone appropriate for the tool and task (either an appropriate subject line in an email message or an appropriate, descriptive voice in a wiki entry); 3) communicating information with an appropriate awareness of audience (using an appropriate greeting in an email message or an appropriate heading in a wiki entry); and 4) communicating a short report of research findings

that includes sources, using an email message or wiki. See Table 3.6 for scoring criteria for communicate.

Table 3.6

Scoring Criteria for the Communicate Scale for the Video Games and Eyesight Task

Item	C1	C2	C3	C4
Purpose of Stem	Wiki Task: Does the student make a wiki entry in the correct location?	Wiki Task: Does the student use descriptive voice in an informational wiki?	Wiki Task: Does the student include an appropriate heading for a new wiki entry?	Wiki Task: Does the student compose and post a well-structured, short report of their research, including sources, in a wiki?
Item Stem	Now, write a short report on the class wiki. Use what you learned to add to the wiki for Mr. Henry and his students.	Now, write a short report on the class wiki. Use what you learned to add to the wiki for Mr. Henry and his students.	First, add a new heading in a location that makes sense. Then take a position: Do video games harm your eyes?	Be certain to explain your thinking. Use evidence from the websites that supports your position about the question: Do video games harm your eyes? Please include your sources. Use website titles.
Scoring Criteria	Student types a wiki entry in the correct location that includes any relevant content in the correct location, either: 1) below the other sections if no heading; 2) anywhere in the wiki below the	Student composes an informational wiki entry in a descriptive voice.	Student composes an appropriate heading in their wiki entry, containing both aspects of the topic (e.g., snacks and heart or health; video games and eyesight or eye	Student composes and saves a wiki post with one relevant claim and two pieces of supporting evidence. They also include at least two sources, listing the names

	Mr. Henry message if they do have a heading on a separate line		health). An appropriate heading must be on a separate line.	of the websites or the urls.
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Discipline and Domain

The discipline of science was selected since this appears to be especially important to the advancement of knowledge and the well-being of nations (National Research Council, 2007; President’s Council of Advisors on Science and Technology, 2010). Within the area of science, the domain of human body systems (eyes, ears, heart, lungs) was selected since this commonly appears in the seventh grade curriculum for many states and nations. Eight learning tasks were selected after over 300 hours of work in cognitive labs on this and other issues to develop and refine the assessments. The learning tasks appear in Table 3.7, below.

Learning Tasks 1 and 3 were developed as “learn more about” questions. They asked students to use electronic mail to compose and send their short research report to the President of the School Board. Learning Tasks 2 and 4 were developed as “investigate conflicting claims” questions. They asked students to conduct research online and use a science classroom’s wiki to take a position and edit the wiki to communicate their results to the class.

Table 3.7

The Four Learning Tasks

Learning Task	Type of Learning Task	Topic	Body System	Communication Tool Used in the Learning Task
1. How do energy drinks affect heart health?	Learn more about	Energy Drinks	Heart	Email

2. Do video games harm your eyes?	Investigate conflicting claims	Video Games	Eyes	Wikis
3. How do snacks affect heart health?	Learn more about	Snacks	Heart	Email
4. Do decorative contact lenses harm your eyes?	Investigate conflicting claims	Contact Lenses	Eyes	Wiki

Correlates

This study compared the online research skills of students residing in a state with a systemic one-to-one laptop initiative (Maine) to the skills of students in a state that has not yet implemented such an initiative (Connecticut). In order to isolate the impacts of the laptop initiative from other factors, it is important to account for key correlates of online literacy that may have different distributions across the states. This section describes key variables that appear to be correlated with online literacy and research skills.

Prior Knowledge. The prior knowledge that students bring to learning tasks plays an important role in understanding (Kintsch, 1998; McNamara & Kintsch, 1996; Voss & Silfies, 1996).

Information that is stated is often insufficient for the construction of a coherent mental representation, requiring the contribution of a reader's prior knowledge (Kintsch, 1998).

Strømsø, Bråten, Britt & Ferguson (2013) found that students' prior knowledge facilitated understanding of offline information. Le Bigot and Rouet (2007) found similar results for online information within a restricted web environment. Given this work, prior knowledge is included in this study to investigate its impact on online research and learning (see Figure 3.3 below).

Figure 3.3. Prior Knowledge Collection Screen in the ORCA

Welcome! What do you know about your heart? Answer each of the questions below about this topic. Click the "Submit" button when you are done.

1. The heart is an organ that belongs to which of the following systems?

- ☐ A. acoustic
- ☐ B. respiratory
- ☐ C. circulatory
- ☐ D. optic

2. The heart mainly:

- ☐ A. produces new blood
- ☐ B. mixes red and white blood cells
- ☐ C. holds blood in its chambers
- ☐ D. pumps blood throughout the body

Socioeconomic Status. Income inequality is rapidly becoming the biggest determinant of academic achievement from among many, broadly based educational indicators in the United States (Lee, 2002; Reardon, 2011). Achievement gaps based on income inequality are not only substantial; they have increased in the past 40 years, while those based on race are decreasing (Reardon, 2011; Bailey & Dynarski, 2011). The difference in reading achievement, based on income inequality, is now more than twice as large as the black-white achievement gap (Reardon, 2011). A separate, income based, achievement gap appears to exist with respect to online research and learning (Leu et al., 2015). This gap may be caused by differences in computer and Internet access at home and at school (National Telecommunications and Information Administration, 2011). It may also be caused by the failure in the United States to include online research and learning tasks in the new standards-based assessments in reading (Drew, 2012). In a climate where the poorest schools are often under the greatest pressure to raise test scores (Darling-Hammond, 2004), economically challenged districts may focus limited

resources on instruction that maps precisely onto the domains emphasized in high stakes testing (Leu, et al., 2015), ignoring online research and learning skills. Given evidence for a correlation between socioeconomic status and online learning we included socioeconomic status in models predicting online research skills. This was especially important in the current study since one state (Connecticut) ranked high in median family income (4th out of 50 states) and the other state (Maine) ranked low in median family income (33rd) (see U.S. Census Bureau, 2010).

Teacher Experience. Teacher quality is a school-level factor that has been found in previous studies to influence student learning outcomes (Goldhaber, 2002). Although large differences in student learning can be found across teachers (Hanushek, Kain, O'Brien, & Rivkin, 2005), most observable teacher characteristics (e.g. certification, degrees, attendance, test scores) explain little of the variance found in teacher performance (Hanushek, 2003). However, one characteristic that does appear to impact teacher performance is the number of years of teaching experience (Darling-Hammond, 2000; Rivkin, Hanushek, & Kain, 2005). Studies have found that years of teaching experience do have a positive effect on student test scores (Clotfelter, Ladd, & Vigdor, 2006; Goldhaber & Anthony, 2007). Because student learning in various domains is often associated with the number of years their teacher has taught, it was included as a variable in our model.

Offline Reading Measures (ORMs). Offline reading measures (ORMs) were developed for the ORCA Project. The purpose was to look at NAEP-based assessments in context with the ORCA Project to develop a suitable standard offline scientific-reading testing standards (Cui, Bruner-Sedransk, Sedransk, 2014). Released passages and sets of test items designed for grades 4, 8, and 12 were collected from the National Assessment of Educational Progress (NAEP). In the ORCA pilot year study, multiple passages and sets of test items were tested with students. After

further study (Cui et al., 2014), it was determined that the best measure of offline reading with the most reliable and valid passages, representing a grade 7 difficulty level, were Sharebots (8th grade) and Blue Crabs (4th grade). Both can be found in Appendix C.

Administration

ORCA data were collected on both assessment days. Assessments days were schedule for approximately half way through the standard school year. Students were randomly assigned to two different formats (ORCA-Scenario or ORCA-Simulated) and two different topics (energy drinks, video games, snacks, contact lenses). Format order was randomized. Students were given one hour to complete each assessment. Prior to beginning each assessment, students were read formal instructions by the ORCA facilitator. The assessments took place on laptop computers, each of which included an automated startup feature to log students into the appropriate account. Students were only required to click on a provided “Go” button to login to the laptop. Students were then directed to log into the ORCA system (see Figure 3.4 below) with their unique identification number (provided by the ORCA system once a student had been registered). Students were next asked to complete a set of demographic questions. Prior to being directed to the actual ORCA-II, students were asked to complete the previously mentioned prior knowledge survey. Once a student was in the assessment, screen recording software was automatically launched and recorded all screen activity during the assessment. Students are made aware that their screen movements would be recorded, however, the screen recording software is a passive system that does not alert the test taker to its presence. Data from each assessment were saved automatically by the ORCA system so that data could be backed up, viewed, and analyzed at a later date. Students completed two additional items outside of the actual ORCA assessments: 1) the ORM, an assessment of traditional, offline reading comprehension in science (Appendix C);

and 2) the Student Internet Use Survey (SIUS) (Appendix A). While students completed the ORCA, teachers completed items on the Teacher Internet Use Survey (TIUS) (Appendix B).

Figure 3.4. Login Screen for the ORCA

Log In

Enter Your ID Number Here:

Welcome, NewLit Lab.

*If you are not NewLit Lab, try re-entering your ID number or ask a monitor to assist you. Otherwise click the **continue** button.*

Scoring

ORCA-Simulated was scored using a binary (0-1) scoring system. All student data were automatically saved within the assessment system. Data were later downloaded to a spreadsheet with pre-configured formulas to facilitate scoring. Format and topic determined which items were automatically scored and which were hand scored for each assessment. Four trained scorers (one for each topic) hand scored necessary items for each assessment in their own separate scoring spreadsheet. Once all responses had been scored as needed by hand, they were combined with the automatically scored data results and uploaded to a secure database.

Scorers were undergraduate students trained to a 90% accuracy rate for each item on their assigned topic. They were not allowed to begin formal scoring until they consistently achieved the 90% accuracy rate. Scorers also checked twenty percent of scores for accuracy randomly.

All scorers were retrained and retested before they could continue scoring if they fell below the 90% accuracy percentage. ORMs were scored for the six items for the Blue Crabs passage using a scoring system of 0 or 1 point for each item. For the five items in the Sharebots passage, two items were scored using 0, 1, or 2 points while the rest of the items were scored using dichotomous scoring. For both passages, the total score for each passage was calculated by summing the score points for each item to determine an overall total ORM score. The procedure for undergraduate scorers in regards to ORM data were similar. For ORM data, in the cases where 90% accuracy was not met, an expert scorer and the undergraduate scorer discussed the scores and agreed on a final score. Each ORM undergraduate scorer scored all items for one of the two passages, with one student scoring all Blue Crabs items and one scoring all Sharebots items. Students' responses for the prior knowledge measures were scored automatically by the ORCA scoring system and entered into the database.

Reliability

ORCA. The reliability of each ORCA was evaluated using the Kuder – Richardson Formula 20 (KR-20). All ORCAs achieved adequate levels of reliability as shown in Table 3.8. Generally, reliability estimates were somewhat higher for the ORCA-Simulated format as opposed to ORCA-Scenario. Previous studies on the ORCA-Simulated assessments for year 3 data found that they demonstrated good reliability, with KR-20 ranging from .86 to .90 depending upon topic (Leu et al., 2014). Year 4 ORCA-Simulated achieved an estimate of 27.6% greater reliability than Year 3 ORCA-Simulated (Maykel, Forzani & Leu, 2014).

Table 3.8

Reliability Estimates for each Assessment Topic in Year 3 and 4

Topic	Format	Reliability KR-20 Year 3	Reliability KR-20 Year 4
Energy Drinks	Simulated	0.72	0.88
Video Games	Simulated	0.82	0.90
Snacks	Simulated	0.69	0.86
Contacts	Simulated	0.73	0.88

Prior Knowledge. To date, there have been no studies of the reliability of the multiple-choice prior domain knowledge measures. The present study will calculate Kuder-Richardson 20 estimates for both topics in the prior domain knowledge measure (DuBois, 1965).

Offline Reading Measure. In a previous analysis using pilot year data, both the Blue Crabs and Sharebots passages were found to have a level of reliability that made them suitable for inclusion in a combined passage test (Cui, Bruner-Sedransk, & Sedransk, 2014).

Validity

Overall ORCA. The ORCA-II was developed as the third generation of the ORCA assessments. With each revision of the ORCA, steps were taken to increase the validity of the assessment instrument. For the pre-pilot ORCA, a group of experts in reading comprehension, online research and comprehension, measurement, assessment, science education, and educational research developed an assessment framework (Leu et al., 2014). The framework that was developed included a definition of online research and comprehension as well as an outline of the major skill areas in this research process: locating, evaluating, synthesizing, and communicating. This framework was used to develop the pre-pilot assessments. This process included meetings and cognitive labs using think-aloud verbal protocols (Ericsson & Simon, 1999; Willis, 1999) with over 300 seventh-grade students over two years. A panel of online

research and comprehension experts then reviewed the proposed score points and suggested revisions.

A similar process was followed for the pilot ORCA and ORCA-IIs. For the pilot ORCA, which was conducted in Year 3, a panel of experts in online research and comprehension reviewed the pre-pilot assessments and developed a set of parallel assessments in two additional formats that included Multiple-choice and Open Internet. Additional cognitive labs using a think-aloud process were conducted (Ericsson & Simon, 1999; Willis, 1999) and used to further revise the assessments.

For the ORCA-IIs, a panel of online research and comprehension experts as well as measurement experts reviewed the data from the original ORCAs and decided to drop the Open format in the final generation of ORCA (ORCA-IIs) for practicality and validity reasons. First, the Open Internet format could not provide a stable Internet context, since it used the Open and ever-changing Internet. Therefore, it was difficult to compare scores across testing times and locations. Additionally, the Open format was time consuming for students to take and for scorers to score and therefore much less practical to use than the other two formats. This same panel also reviewed the eight different topics used in the ORCA-IIs and decided to retain only the four topics that had the best reliability and validity estimates. The panel of online research and comprehension experts then used the data from the scores of the original ORCAs to revise the assessment items to produce items that would further increase the reliability and validity of conclusions drawn from the data. (For a more complete description of reliability and validity procedures, see Leu et al., 2014.) For the remainder of this paper, the name ORCA is used to refer to the ORCA-II version of the assessment not the original ORCA.

Prior Knowledge. Validity for the measure of student prior knowledge in science was established via cognitive labs over a two-year period including approximately 300 students. Student think aloud protocol was analyzed to determine the extent to which this approach was viable. Adjustments in this measure were made including the use of a multiple-choice question instead of the think aloud protocol. These changes provided a measure that allowed for comparisons to be made across all students and format/topic scenarios.

Offline Reading Measures (ORMs). In a prior analysis using pilot year data, exploratory factor analysis using a promax rotation was conducted for each of the two passages separately and confirmed that a one factor solution was appropriate for both passages (Cui et al., 2014). In this analysis, for the Blue Crabs passage, promax factor loadings indicated a range from .160 to .727 and, for the Sharebots passage, promax factor loadings indicated a range from .401 to .819. In another analysis using pilot year data, both the Blue Crabs and Sharebots passages were found to have a level of reliability that made them suitable for inclusion in a combined passage test (Cui et al., 2014). For the Blue Crabs passage, Cronbach's alpha for the raw score was .61 and for the standardized score was .62. For the Sharebots passage, Cronbach's alpha for both the raw and standardized scores was .57.

Analysis

Each of the first three research questions for this study were replications of the research questions addressed in Kennedy et al. (2016). The final research question 4 is a new research question that was not covered in the replicated study from the pilot year.

Research Question 1- Year 3 Pilot Study

Did significant differences appear between students in the two states on scores for any of the covariates: SES, prior domain knowledge scores, and teacher experience?

In the ORCA pilot year study, year 3 data revealed the following confirmatory information regarding relevant variables. Chi-square test of independence analyses conducted on the responses by teachers to the two questionnaire items were used to confirm that all students in Maine had their own laptops to use in their classrooms and that none of the students in Connecticut had their own laptops and that students in Maine were required to use the Internet for assignments more often than students in Connecticut. Also, in the pilot study, the researchers were interested in learning how ORCA scores differed across the different formats used and the different learning tasks. Mean scores were computed for each format type. Pairwise comparisons were made for all format types. Statistical tests were based on a test of the regression coefficient associated with the dummy variable for format in a multi-level regression with students nested within schools. P-values were adjusted for multiple comparisons using the procedure described in Holm (1979). Holm's method provides strong control of the family-wise error rate and is valid under arbitrary assumptions about the relationship between the hypothesis tests.

Additional important control variables were also examined as they were included in the final regression analyses and found to be correlated with online research skills. These examined control variables included socioeconomic status, prior domain knowledge scores, and years of teacher experience. Specifically, the initial study examined if the average value of indicators for socioeconomic status, prior knowledge scores, and years of teacher experience differed between Maine and Connecticut. As a preliminary analysis, the states were compared to see if the average value of these variables differed across the states. In the data, socioeconomic status and teacher experience were school level variables (since there was only one teacher per school), prior knowledge was a student level variable. The socioeconomic status comparison was

accomplished with a simple t test. Teacher experience was measured as a categorical variable; thus a comparison was made with a chi-squared test of independence. The comparison with respect to prior knowledge required an HLM analysis that accounted for the clustering of students within schools.

Research Question 1- Year 4 Validation Study

Did significant differences appear between students in the two states on scores for any of the covariates: SES, prior domain knowledge scores, offline reading, and teacher experience?

Research question #1 of the current validation study, using year 4 ORCA data, took a similar but somewhat more extensive approach to the confirmatory analysis of control variables. To evaluate the differences in the variables between the two states, multiple tests were conducted to test for mean differences by state. A simple t test was used to look at initial differences between state ORCA Total scores and individual ORCA Total measures (Locate, Evaluate, Synthesize, Communicate) before conditioning on any co-variables. In the year 4 data, socioeconomic status and teacher experience are school level variables and offline reading and prior knowledge are student level variables. A socioeconomic status and teacher experience comparison were accomplished with a simple t test. Unlike in the initial study, teacher experience was not a categorical variable in year 4 but a continuous measure of total years of teacher experience. A comparison with respect to prior knowledge and offline reading required a hierarchical linear model analysis that accounted for the clustering of students within schools in the initial study. In this study, a simple t test would not be correct for student level variables. An HLM analysis was used to compare mean prior knowledge and mean offline reading measures by state and to determine the standard error of the difference between the means on these

variables across the states. This approach allows for the better examination of these control variables while considering the clustering of the students within schools within each state.

In addition, a supplemental analysis was conducted to determine both student access to the Internet (access to laptops in a one-to-one environment) and frequency of use of the Internet for classroom activities (how often Internet based assignments were assigned). Chi-square analyses were conducted on the responses by teachers to the two questionnaire items were used to confirm: 1) that all students in Maine had their own laptops to use in their classrooms and that none of the students in Connecticut had their own laptops and 2) that students in Maine were required to use the Internet for assignments more often than students in Connecticut.

Research Question 2 – Year 3 Pilot Study

After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning for students in the state with a one-to-one computer policy?

In the pilot study, using year 3 data, researchers sought to evaluate the effect of a one-to-one laptop policy on overall ORCA Total scores after conditioning on covariates. To achieve this goal, they conducted two multilevel multivariate regression analyses using a procedure outlined in Hox (2010, pp. 188-192). The four response variable scores (locate, evaluate, synthesize and communicate) formed the first level of their model. The student defined the second level and schools defined the third level. All models included random intercepts but not random slopes. All models included dummy variables for format type (with “Open” as the reference category), dummy variables for learning task (with “Ringtones” as the reference category), state (with Connecticut as the reference category), socioeconomic status and teacher experience. One model included the prior knowledge variable and the other excluded it. The two separate models were

fit due to ambiguity about the appropriateness of including prior knowledge as a covariate.

While prior knowledge was a potential confounding factor of the relationship between the laptop policy and ORCA outcomes, it is also possible that prior knowledge scores could themselves have been influenced by the laptop policy. Due to this ambiguity, the model was fit both with and without the prior knowledge variable. The results of the study showed that prior knowledge was not a confounding variable since it was not significant in explaining variance in the model. For both models, an effect size for the laptop policy was computed using Hedges' g (Hedges, 1981). Hedges' g was calculated as the regression coefficient for State divided by the pooled estimate of the unconditional standard deviation of the ORCA scores.

Research Question 2 - Year 4 Validation Study

After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning for students in the state with a one-to-one computer policy?

Research question #2 of this study, using year 4 ORCA data, took a similar but slightly more extensive approach to the analysis of ORCA Total between the states. To evaluate the effect of a one-to-one laptop policy after conditioning on the covariates that we identified, two separate HLM regression analyses, using total ORCA scores (out of 16) as the dependent variable, an indicator variable for state as an independent variable and two different sets of covariates, were conducted using a procedure outlined in Hox (2010, pp. 188-192). The four response variable scores (locate, evaluate, synthesize and communicate) formed the first level of the model. The student defined the second level and schools defined the third level. Two models were run one that included the prior knowledge variable and the other that excluded it. Both models included teacher experience and a measure of offline reading measure. Offline reading

measures were not available for all students in the year 3 initial study therefore this variable was not available for analysis until year 4 data. All models included random intercepts but not random slopes. All models included dummy variables for learning task (with contact lenses as the reference category) and state (with Connecticut as the reference category). The two separate models were replicated from the previous study and so as to address any vagueness about the appropriateness of including prior knowledge as a covariate. For both models, an effect size for the laptop policy was calculated using Hedges' g . Hedges' g is calculated as the regression coefficient for State divided by the pooled estimate of the unconditional standard deviation of total ORCA scores and used individual level sample sizes.

Research Question 3 – Year 3 Pilot Study

After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score for any of the separate component scores of online research and learning (locate, evaluate, synthesize, communicate) for students in the state with a one-to-one computer policy?

In the pilot study, using year 3 data, researchers also sought to evaluate the effect of a one-to-one laptop policy separately on each component score (locate, evaluate, synthesis, and communicate) for online research and learning, after conditioning on relevant covariates. The results provided information about specific aspects of online research and learning that are most sensitive to a one-to-one laptop policy and provided important understanding and direction for classroom instruction. For this set of analyses two separate multivariate multilevel models were again fit with measures nested within students nested within schools. For this research question dummy variables representing the four response variable types (locate, evaluate, synthesize and communicate) were included in the model. All other independent variables were fully interacted with this set of dummy variables. This model allowed the researchers to separately explore the

relationship of state with the four dimensions of online research and comprehension while still accounting for the correlation between the four dependent variables. As was the case in the previous research question from the initial study, the two models differed only with respect to the inclusion or exclusion of prior knowledge as a covariate. For each response variable type, Hedges' g was again calculated as the regression coefficient for State divided by the pooled estimate of the unconditional standard deviation of the ORCA scores.

Research Question 3 - Year 4 Validation Study

After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score for any of the separate component scores of online research and learning (locate, evaluate, synthesize, communicate) for students in the state with a one-to-one computer policy?

Research question #3 of this study, using year 4 ORCA data, took a similar approach to the analysis of the individual ORCA components between the states. To evaluate the effect of a one-to-one laptop policy on the component scores for online research and learning, after conditioning on relevant covariates, two separate HLM models were fit for each of the four dependent variables of interest (Locate, Evaluate, Synthesize and Communicate total scores). In this instance dummy variables representing the four response variable types (locate, evaluate, synthesize and communicate) were included in the model. All other independent variables fully interacted with the set of dummy variables. This allowed for the separate exploration of the relationship between state and the four dimensions of online research and learning while still accounting for the correlation between the five (original four plus offline reading measure) dependent variables. As was the case with research question #2, the two models differed only with respect to the inclusion of prior knowledge as a covariate. For each response variable type,

Hedges' g was again calculated as the regression coefficient for State divided by the pooled estimate of the unconditional standard deviation of the ORCA scores.

Research Question 4 – Year 4 Validation Study

Is there a relationship between teacher practices used for student online research and learning success and ORCA performance as measured by teacher and student responses on Internet use surveys?

Research question #4 of the current study, using year 4 ORCA data, was not addressed in the initial study. This question sought to evaluate a possible relationship between teacher instructional practices and student performance as measured by ORCA scores. A discovery approach was taken looking at survey questions that address Internet frequency of use and student Internet time on task. The questions that were taken from the teacher and student Internet use surveys included:

From the Teacher Internet Use Survey (see appendix B)

- a. About how many days per month (out of 28 days) do you REQUIRE students to use the Internet for a school assignment?
- b. About how many days per month (out of 28 days) would you estimate that students CHOOSE to use Internet for a school assignment?
- c. On average, about how much time EACH DAY do students use the Internet in each of your classes?
- d. Which of the following best describes your students' individual access to a computer/laptop/iPad/netbook, etc. during your English Language Arts class? (0=Never, 1=Rarely, 2=Sometimes, 3=Often, 4=Always)

From the Student Internet Use Survey (see appendix A)

- a. For your English Language Arts class, about how many days per month (out of 28 days) do you work on assignments where your teacher REQUIRED you to use the Internet?
- b. For your English Language Arts class, about how many days per month (out of 28 days) do you work on assignments where you CHOOSE to use the Internet, even though it is not required?
- c. On average, about how much time EACH DAY do you use the Internet at school?
- d. Do you have your own laptop that you use at school and home?

First, a confirmatory analysis was run between each identified survey question and ORCA Total disaggregated by state. An HLM analysis was conducted on the responses by teachers and students to the eight questionnaire items and were used to confirm differences between the states. Second, a correlation analysis was run across corresponding questions between the teacher and student surveys also disaggregated by state to identify consistency across similar question between students and teachers. Based on this initial discovery process, it was found that a third HLM regression analysis, as proposed, was necessary to fully explore the relationship between frequency of use and time on task and ORCA performance by State using standardized data to compare predictive ability.

Evaluating the Loss of Data

Four unique sets of analyses were conducted to estimate the impact of missing data on each of the corresponding four research questions. Each research question has a unique set of data fields. By analyzing the data for each question, I was able to maximize the complete data set and minimize removing cases for incomplete data,

Research Questions #1, #2, and #3. A total of N=1,377 participants were included in the analysis for research question #1 from the original 1,628 participants who participated in the ORCA Simulated. The 251 students who were not included in the analysis for research question #1 had missing ORCA and demographic data or did not successful complete all parts of the ORCA assessment including the student offline reading measures and test for prior knowledge.

All students who participated in the ORCA-Simulated, including some with missing data (N=1,628), were compared to those students who had complete ORCA-Simulated data (N=1,377) to see if significant differences were present using HLM on the following variables: Prior Knowledge and ORCA Total score. Of the 1,628 total records, many of them were missing

variables including ORCA scores, offline reading measures, Internet use survey responses, prior knowledge scores, etc.

Of the total 1,628 ORCA-Simulated records, 1,627 have complete information for Prior Knowledge. Of the total 1,628 ORCA-Simulated records, 1,494 have completed information for ORCA Total score. There were no significant differences on either of these variables when comparing the total 1,628 records with each of the complete sets of data for Prior Knowledge and ORCA Total scores respectively. For Prior Knowledge (for students with a complete ORCA-Simulated data, $M = 4.72$; $SD = 1.634$; for all students who participated in ORCA-Simulated, $M = 4.71$; $SD = 1.644$), $t(3,002) = 0.256$, $p = .798$, two-tailed. For ORCA Total (for students with a complete ORCA-Simulated data, $M = 7.24$; $SD = 3.364$; for all students who participated in ORCA-Simulated, $M = 7.22$; $SD = 3.375$), $t(2,869) = 0.176$, $p = .861$, two-tailed.

Research Question #4. A total of $N=1,332$ participants were included in the analysis for research question #4 from the original 1,628 participants who participated in the ORCA-Simulated. The 296 students who were not included in this analysis for research question #4 had missing ORCA and demographic data or did not successfully complete all parts of the ORCA assessment including the student offline reading measures, test for prior knowledge, and/or the Internet use survey.

All students who participated in the ORCA-Simulated including some missing data ($N=1,628$) were compared to those students who had complete ORCA-Simulated data ($N=1,332$) to see if significant differences were present using independent samples t-tests, on the following variables: Prior Knowledge and ORCA Total score. There were no significant differences on either of these variables. For Prior Knowledge (for students with a complete ORCA-Simulated data, $M = 4.72$; $SD = 1.629$; for all students who participated in ORCA-Simulated, $M = 4.71$; SD

= 1.644), $t(2,957) = 0.187$, $p = .852$, two-tailed. For ORCA Total (for students with a complete ORCA-Simulated data, $M = 7.22$; $SD = 3.369$; for all students who participated in ORCA-Simulated, $M = 7.22$; $SD = 3.375$), $t(2,824) = 0.031$, $p = .975$, two-tailed.

Chapter Summary

This chapter sought to clearly illustrate and procedures and methodology used to replicate the year 3 data study in this current study. A summary of the data analyses used in this current study can be found below in table 3.9

Table 3.9

Methodology and Data Analysis Methods for the Four Research Questions

RQ#	Research Question	Methodology	Analysis Method
1	Did significant differences appear between students in the two states on scores for any of the covariates: SES, prior domain knowledge scores, offline reading measures, and teacher experience?	Simple t test Chi-square	Multiple simple t tests to determine group mean differences Multiple Chi-square tests of independence to examine relationships of multiple variables
2	After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning (ORCA Total) for students in the state with a one-to-one computer policy?	Hierarchical Linear Modeling	Three-level hierarchical linear modeling IVs: PK, SES, ORM, Teacher Experience DV: ORCA total (out of 16 points)
3	After conditioning on differences in the scores for the covariates, is there evidence of a higher mean scores on an assessment of online research and learning (for each individual ORCA Total component Locate,	Hierarchical Linear Modeling	Three-level hierarchical linear modeling IVs: PK, SES, ORM, Teacher Experience DV: Locate total (out of 4 points) DV: Evaluate total (out of 4 points)

	Evaluate, Synthesize, and Communicate) for students in the state with a one-to-one computer policy?		DV: Synthesize total (out of 4 points) DV: Communicate total (out of 4 points)
4	Is there a relationship between teacher practices used for student online research and learning success and ORCA performance as measured by teacher and student responses on the Internet use surveys?	Descriptive Chi-square Correlation Hierarchical Linear Modeling	Identify group mean differences Multiple Chi-square tests of independence to examine relationships of multiple variables Correlation analysis to identify validity of data Explore the relationship between frequency of use and time on task and ORCA performance by State

Note: IV is independent variable; DV is dependent variable; SES is socioeconomic status as measured by free and reduced price lunch by school; PK is prior student knowledge; ORM is a student offline reading measure.

CHAPTER 4

RESULTS

The purpose of this research study was to verify the results of the findings from Kennedy, Rhodes & Leu (2016) through a replication study and to extend the understanding of the findings through the investigation of more comprehensive teacher and student Internet use surveys. To answer these questions, I used identical statistical techniques to the initial study where possible and appropriate and updated methods based upon changes to the ORCA instrument specifically in both Internet use surveys.

Did significant differences appear between students in the two states on scores for any of the covariates: SES, prior domain knowledge scores, offline reading, and teacher experience?

Prior to beginning work on this first question, a series of analyses were conducted to confirm that states differed in student access to laptops and states differed in the use of laptops in classrooms. Data on the assessment are presented. Following this, the results to research question #1 are presented.

Research question 1 in the pilot study, using year 3 data, sought to confirm statistical results of important correlates. Research question 1 from this study, using year 4 data, also sought to confirm statistical results of important correlates: “Did significant differences appear between students in the two states on scores for any of the covariates: SES, prior domain knowledge scores, offline reading measures, and teacher experience?” Throughout this section results from the pilot year ORCA study using year 3 data and validation year ORCA study using year 4 data will be presented and grouped together.

Laptop Access

Pilot. Table 4.1 presents the analysis for the first item: “*Do all students have their own laptop/computer in your classroom?*” Chi-square results show a statistically significant relationship ($X^2 = 41.0^*$, $df = 1$, $p < .000$) between student access to laptops within the classrooms of the two states. All Maine teachers in our sample report that students had their own laptops in the classroom. None of the Connecticut teachers in our sample reported students’ having their own laptops in the classroom.

Table 4.1

Results of Chi-Square Test and Descriptive Statistics for Student Laptop Access in the Classroom by State as Reported by Classroom Teachers

Question	Do all students have their own laptop/computer in your classroom? (Yes/No)	
Laptop	Yes	No
Connecticut	0 (0%)	20 (100%)
Maine	21 (100%)	0 (0%)

Validation. Table 4.2 presents the analysis for the student item: “Do you have your own laptop that you use at school and home?” on the student Internet use survey.

Table 4.2

Results of Chi-Square Test and Descriptive Statistics for Student Laptop Access in the Classroom and at Home by State as Reported by Students

Question	Do you have your own laptop that you use at school and home? (Yes/No)	
Laptop	Yes	No

Connecticut	244 (35%)	451 (65%)
Maine	482 (76%)	155 (24%)

Table 4.3 presents the analysis for the teacher item: “Which of the following best describes your students’ individual access to a computer/laptop/iPad/netbook, etc. During your English Language Arts class?” on the teacher Internet use survey. Chi-square results show a statistically significant relationship ($X^2 = 37.0^*$, $df = 4$, $p < .000$) between student access to laptops within the classrooms of the two states.

Table 4.3

Results of Chi-Square Test and Descriptive Statistics for Student Laptop Access in the English Language Arts Classroom by State as Reported by Teachers

Question	Which of the following best describes your students’ individual access to a computer/laptop/iPad/netbook, etc. During your English Language Arts class?				
Answer	Never	Rarely	Sometimes	Often	Always
Connecticut	2 (8.3%)	6 (25.0%)	14 (58.3%)	2 (8.3%)	0 (0.0%)
Maine	0 (0.0%)	0 (0.0%)	2 (7.7%)	6 (23.1%)	18 (69.2%)

It should be noted that the one-to-one program in Maine started in the 7th grade. At the time of the administration of the ORCA to Maine students they would have had access for approximately half of a school year.

Required Internet Use

Pilot. Table 4.4 presents the analysis for the frequency with which the Internet was used in the classrooms of the samples from the two states: “About how often do you *REQUIRE* students to use the Internet for a school assignment?” Chi-square test of independence shows a statistically significant relationship ($X^2 = 31.664$, $df = 4$, $p < .000$) between responses by teachers in the two

states. In Maine (with laptops) 71.4% of teachers reported requiring students to use the Internet for a school assignment at least once a week, compared to only 5% of teachers in Connecticut (without laptops).

Table 4.4

Results of Chi-Square Test and Descriptive Statistics for how often teachers require student use the Internet for a school assignment as reported by classroom teachers

Question	About how often do you REQUIRE students to use the Internet for a school assignment?				
Answer	I have not done this yet	A few times each year	Once a month	Once a week	More than once a week
Connecticut	3 (15.0%)	8 (40.0%)	8 (40.0%)	1 (5.0%)	0 (0.0%)
Maine	0 (0.0%)	0 (0.0%)	6 (28.6%)	7 (33.3%)	8 (38.1%)

Validation. Table 4.5 presents the analysis for the frequency with which the Internet was used in the classrooms of the samples from the two states: “About how many days per month (out of 28 days) do you REQUIRE students to use the Internet for a school assignment?” Students in Maine had higher number of days mean scores (Mean = 14.92, SD = 5.34, n = 26) compared to students in Connecticut (Mean = 4.54, SD = 4.42, n = 24). A simple *t* test was used to evaluate the difference in these means and showed a significant difference between scores ($t = -7.54$, $df = 48$).

Table 4.5

Results of Chi-Square Test and Descriptive Statistics for how many days per month teachers require student use the Internet for a school assignment as reported by classroom teachers

Question	About how many days per month (out of 28 days) do you REQUIRE students to use the Internet for a school assignment?
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Days	Mean	SD
Connecticut	4.54	4.42
Maine	14.92	5.34

Assessment Format

Pilot. Table 4.6 presents the average scores for each assessment format. After applying Holm's correction to the p values, the mean score for the Scenario format was significantly different from both the Open and the Simulation formats ($p < 0.001$). However, the difference between the Simulation and Open formats was not statistically significant.

Table 4.6

Mean, Standard Deviation, and Sample Size for ORCA scores (out of 32)

	TOTAL		
	M	SD	N
Scenario	22.11	5.33	404
Simulation	15.57	5.50	392
Open	16.31	6.14	333

Validation. A corresponding analysis was not completed for format in the current study because only one format, ORCA-Simulated, was analyzed. Table 4.7 presents the average scores for all Simulation formats.

Table 4.7

Mean, Standard Deviation, and Sample Size for ORCA scores (out of 16)

	TOTAL		
	M	SD	N
Simulation	7.24	3.36	1377

Learning Tasks

Pilot. Table 4.8 presents the average scores for each assessment topic. The omnibus test for the significance of the learning task factor was highly significant.

Table 4.8

Mean, Standard Deviation, and Sample Size for ORCA scores (out of 16) for different learning Topics – Pilot Year

	TOTAL		
	M	SD	N
Energy Drinks	9.80	3.42	303
Asthma	8.34	3.00	291
Video Games	10.00	3.56	280
Volume Level	8.91	3.54	277
Healthy Snacks	8.46	3.07	280
Smoking	9.18	3.66	280
Contacts	9.46	3.44	274
Ringtones	8.32	2.96	273

Validation. Table 4.9 presents the average scores for each assessment format. The omnibus test for the significance of the learning task factor (using an ANOVA procedure) was highly significant ($p < .001$).

Table 4.9

Mean, Standard Deviation, and Sample Size for ORCA scores (out of 16) for different learning Subjects – Validation year

	TOTAL		
	M	SD	N
Energy Drinks	7.85	3.20	333

Video Games	7.71	3.64	340
Healthy Snacks	6.91	3.22	369
Contacts	6.53	3.22	335

Socioeconomic Status

Pilot. The mean percentages of students receiving free and reduced price lunches for the sampled schools in each state were compared using an independent sample t test. Results showed that students in Maine, with laptops, attended schools with a higher mean percentage of students who received free and reduced price lunches (Mean = 46.14%, SD = 15.97), compared to students in Connecticut (Mean = 28.31%, SD = 26.09). The difference in these means was significant ($t = -2.679$, $df = 39$, $p = .011$) and the effect size was large (Cohens $d = 0.84$). These results are consistent with the overall state differences in median family income reported earlier and support the idea that our sample plan identified schools reflecting the lower socioeconomic status levels in Maine, compared to Connecticut.

Validation. The mean percentages of students receiving free and reduced price lunches for the sampled schools in each state were compared using an independent sample t test. Results showed that students in Maine, attended schools with a higher mean percentage of students who received free and reduced price lunches (Mean = 44.94%, SD = 19.62), compared to students in Connecticut (Mean = 29.38%, SD = 27.20). The difference in these means was significant ($t = -2.105$, $df = 38$, $p = .042$) and the effect size was large (Cohens $d = 0.66$). These results are again consistent with the overall state differences in median family income.

Prior Knowledge

Pilot. Students in Connecticut (without laptops) had higher mean prior domain knowledge scores (Mean = 6.50, SD = 6.70, $n = 614$) compared to students in Maine (Mean = 5.01, SD = 5.24, $n =$

515). HLM was used to evaluate the difference in these means and showed a significant difference between scores ($t = 2.56$, $df = 39$, $p = .017$). The effect size was small (Hedges $g = 0.24$).

Validation. Due to the nested nature of data collected, two analyses were calculated to evaluate the overall comparison of prior knowledge scores between the two states. The first analysis compared students between the states, the second compared schools between the states. In the first analysis, Students in Connecticut had higher mean prior domain knowledge scores (Mean = 4.81, SD = 1.67, $n = 729$) compared to students in Maine (Mean = 4.63, SD = 1.59, $n = 648$). A simple t test was used to evaluate the difference in these means and showed a significant difference between scores. In the second analysis, Schools in Connecticut had higher mean prior domain knowledge scores (Mean = 4.90, SD = 0.57, $n = 17$) compared to students in Maine (Mean = 4.65, SD = 0.43, $n = 23$). An HLM analysis was used to evaluate the difference in these means and did not show a significant difference between scores ($t = -1.57$, $df = 38$, $p = .123$).

Teacher Experience

Pilot. Table 4.10 presents the number of years of teaching experience reported by teachers in the two states in terms of frequencies and row percentages within five different bandwidths. While a greater percentage of teachers in Maine reported teaching experience in the upper two bandwidths (52.4%) compared to teachers in Connecticut (25.0%), the Chi-square test of independence do not show a statistically significant relationship in the years taught between teachers in the two States ($X^2 = 8.214$, $df = 4$, $p > .05$).

Table 4.10

Results of Chi-Square Test and Descriptive Statistics for The Number of Years of Teaching Experience, as Reported by Teachers in the Samples from Two States

Question	How many years have you taught?				
Years	1-5	6-10	11-15	16-20	More than 20
Connecticut	7 (35.0%)	2 (10.0%)	6 (30.0%)	1 (5.0%)	4 (20.0%)
Maine	1 (4.8%)	4 (19.0%)	5 (23.8%)	3 (14.3%)	8 (38.1%)

Validation. Because teacher experience was measured as a continuous variable in year 4 ORCA data, as opposed to categorical in year 3 ORCA data, a simple t test was used for analysis versus a Chi-square test of independence. Teachers in Maine reported higher mean years of experience (Mean = 19.00, SD = 9.53, $n = 26$) compared to teachers in Connecticut (Mean = 14.13, SD = 10.09, $n = 24$). A simple t test was used to evaluate the difference in these means and did not show a significant difference between scores ($t = -1.76$, $df = 48$, $p = .085$).

Offline Reading Measure

Pilot. A measure of offline reading (ORM) was not included in the analysis in the pilot year study.

Validation. Due to the nested nature of data collected, two analyses were calculated to evaluate the overall comparison of offline reading measures scores between the two states. Students in Maine had higher mean offline reading measure scores (Mean = 9.42, SD = 2.90, $n = 648$) compared to students in Connecticut (Mean = 9.20, SD = 3.19, $n = 729$). A simple t test was used to evaluate the difference in these means and did not show a significant difference between scores ($t = -1.30$, $df = 1375$, $p = .193$). Schools in Connecticut had higher mean offline reading measure scores (Mean = 9.29, SD = 1.40, $n = 17$) compared to schools in Maine (Mean = 9.27, SD = 1.19, $n = 23$). An HLM analysis was used to evaluate the difference in these means and did not show a significant difference between scores ($t = 0.06$, $df = 38$, $p = .955$).

ORCA Scores

Pilot. Performance by students in the two states on the assessment of online research and learning year 3 is summarized in Table 4.11. Please note that the replicated study included two ORCA assessments each with a total of 16 score points for a grand total of a possible 32 score points. While students in Connecticut scored higher overall and in three of the four domains (evaluate, synthesis, communicate, Table 4.11 does not account for known correlates of online research skills that differ across the states.

Table 4.11

Means, SDs, and Sample Size by State On The Assessment of Online Research and Learning – Pilot Year

	Connecticut			Maine			Total		
	M	SD	N	M	SD	N	M	SD	N
Locate Score (out of 8)	4.55	2.20	614	4.60	2.21	515	4.57	2.21	1129
Evaluate Score (out of 8)	3.63	1.88	614	3.29	1.86	515	3.47	1.88	1129
Synthesis Score (out of 8)	6.09	1.79	614	5.83	1.96	515	5.97	1.88	1129
Communicate Score (out of 8)	4.25	2.27	614	3.95	2.24	515	4.11	2.26	1129
TOTAL Score (out of 32)	18.51	6.11	614	17.67	6.15	515	18.13	6.14	1129

Validation. Performance by students in the two states on the assessment of online research and learning year 4 is summarized in Table 4.12. Please note that the replicated study included only one ORCA assessment a total of 16 score points. Students in Maine had higher mean locate scores compared to students in Connecticut. A simple t test was used to evaluate the difference in these means and did not show a significant difference between scores ($t = -1.028$, $df = 1375$).

Students in Connecticut had higher mean evaluate scores compared to students in Maine. A simple t test was used to evaluate the difference in these means and showed a significant difference between scores ($t = 2.880$, $df = 1375$). Students in Connecticut had higher mean synthesize scores compared to students in Maine. A simple t test was used to evaluate the difference in these means and showed a significant difference between scores ($t = 3.539$, $df = 1375$). Students in Connecticut had higher mean communicate scores compared to students in Maine. A simple t test was used to evaluate the difference in these means and did not show a significant difference between scores ($t = 0.535$, $df = 1375$). Students in Connecticut had higher mean ORCA total scores compared to students in Maine. A simple t test was used to evaluate the difference in these means and showed a significant difference between scores ($t = 2.093$, $df = 1375$). While students in Connecticut had higher overall means that were significant in three of the four domains, the t tests and Table 4.12 do not account for known correlates of online research skills that differ across the states.

Table 4.12

Means, SDs, and Sample Size by State On The Assessment of Online Research and Learning – Validation Year

	Connecticut			Maine			Total		
	M	SD	N	M	SD	N	M	SD	N
Locate Score (out of 4)	1.81	1.22	729	1.88	1.25	648	1.84	1.24	1377
Evaluate Score (out of 4)	1.58*	1.00	729	1.42	0.95	648	1.50	0.98	1377
Synthesis Score (out of 4)	2.54*	1.36	729	2.28	1.35	648	2.42	1.37	1377
Communicate Score (out of 4)	1.50	1.30	729	1.46	1.24	648	1.48	1.27	1377

TOTAL Score (out of 16)	7.42	3.41	729	7.04	3.31	648	7.24	3.36	1377
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Note: * = $p < .10$

Summary and Comparison of Results for Research Question 1

The first set of analyses examined the important correlates associated with online research and learning. The first set also provided a side-by-side comparison of results from the replicated study (year 3 ORCA data) and the current study (year 4 ORCA data). An important difference can be seen between the number of students by state that has access to laptops in the classroom between years 3 and 4. In the replicated study for year 3 data, both teachers and students reported 100% access for Maine students and 0% access for Connecticut Students. In the current study for year 4 data, both teachers and students reported mixed results. In Maine, only 76% of students, versus 35% in Connecticut, reported having access to a laptop. Teachers in Maine reported students had access more often than teachers in Connecticut the difference was significant. Differences in access to laptops reported by students and teachers match those reported in year 3 and year 4 overall, however, year 3 demonstrated a stark difference whereas year 4 showed more mixed results with Connecticut having greater access year over year and Maine having less.

Regarding the time that Internet use is required by teachers in each state, for both the replicated and current study, Maine teachers reported significantly more time for both year 3 and year 4. Because of the differences in the question format on the teacher Internet use survey we cannot draw a direct comparison in values. However, the analysis makes it clear that in year 3 in Maine 71.4% of teachers reported requiring students to use the Internet for a school assignment at least once a week, compared to only 5% of teachers in Connecticut and in year 4, Maine

teachers reported almost 15 days of required Internet use versus only approximately 4.5 days reported by Connecticut teachers.

The mean percentages of students receiving free and reduced price lunches for schools in Maine and Connecticut, the measure used for socioeconomic status, showed that students in Maine attended schools in districts with a significantly higher level of need than students in Connecticut for both the replicated and current study.

In a comparison of the measure of prior scientific knowledge by students, in both years 3 and 4 Connecticut students were found to have a higher mean prior knowledge score versus Maine students. The comparison was significant in year 3. However, in year 4 it was found that a student comparison of measure of prior knowledge was significant between Connecticut students and Maine students, but not significant between Connecticut schools and Maine schools ($t = -1.57$, $df = 38$) which addresses the clustering nature of the data.

In both the pilot and validation studies, it was found that there were no significant differences in the years of teaching experience between the groups of teachers in each state. However, in the replicated study, more Maine teachers reported years of experience in the upper two bandwidths (52.4%) compared to teachers in Connecticut (25.0%) and in the current study, Maine teachers had a higher average number of years of teaching experience ($M=19.00$) versus Connecticut teachers ($M=14.13$).

Performance by students in the two states on the assessment of online research and learning on each the skill areas mirrored the results between the replicated and current studies. While students in Connecticut scored higher overall and in three of the four skill area domains in year 3, they also scored higher in three of the four skill area domains in year 4. Students in Maine only performed better in the locate skill area in both years. In a direct comparison of each

of the skill areas and the ORCA total scores between students in Maine and Connecticut, only the differences in the skill areas of synthesize and evaluate and the overall ORCA total were significant. Please note, as mentioned above, the comparisons in research question 1 do not account for known correlates of online research skills that differ between the states. These will be done in research questions 2 and 3 of the current study.

After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning for students in the state with a one-to-one computer policy?

Research question 2 in the pilot study used a multilevel multivariate HLM model to predict the overall performance of students on the ORCA assessments while conditioning on important covariates for the ORCA total student score. Research question 2 from the pilot study (year 3 data) was: “After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning for students in the state with a one-to-one computer policy?” Research question 2 from the current study is nearly identical in its purpose to predict overall performance while still conditioning on important covariates. Research question 2 from the current study (year 4 data) was: “After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score on an assessment of online research and learning (ORCA Total) for students in the state with a one-to-one computer policy?” To evaluate the effect of a one-to-one laptop policy after conditioning on the covariates that were identified, two separate HLM regression analyses were completed. The current study used total ORCA scores (out of 16) as the dependent variable, an indicator variable for state as an independent variable and two different sets of covariates.

Pilot Study Research Question 2

Results of the multilevel multivariate HLM model predicting the overall performance of students on the ORCA assessments while conditioning on important covariates are presented in the first column of Tables 4.13 and 4.14. Table 4.13 excludes the prior knowledge covariate, whereas table 4.14 includes this covariate.

The results found in Tables 4.13 and 4.14 provide evidence that membership in a state (Maine) with a one-to-one laptop policy had a positive impact on students' online research and learning. The results found in the first column of Tables 4.13 and 4.14 are estimates of the average relationship between the independent variables and ORCA scores. After accounting for the differences between Maine and Connecticut with respect to the important covariates, a positive association between residency in Maine and ORCA scores was found (State = 0.18 significant at the $p \leq .01$ level). This association was consistent across both models (with and without Prior Knowledge as a covariate) and was statistically significant in each model.

Table 4.13

Multivariate multi-level models excluding prior knowledge – Pilot Study

Outcome	All
<i>Fixed Effects</i>	
Intercept	1.57*** (0.06)
State (1=ME)	0.18** (0.06)
Teacher Experience	0.01 (0.02)
SES (% FRL)	-0.01*** (.001)
Format=scenario	0.76*** (0.05)
Format=simulation	-0.08 ⁺ (0.05)
Topic=energy drinks	0.36*** (0.06)
Topic=asthma	0.008 (0.05)
Topic=video games	0.44*** (0.05)
Topic=volume level	0.11* (0.06)

Topic=healthy snacks	0.02 (0.06)
Topic=smoking	0.16** (0.06)
Topic=contacts	0.27*** (0.06)

Fixed Effects

Hedges' g for state	0.14
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Note: Numbers in parentheses are standard errors. All models are based on 41 schools and 1085 students. All non-dummy variables (i.e. SES, teacher experience) are grand mean centered. ⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Table 4.14

Multivariate multi-level models including prior knowledge – Pilot Study

Outcome	All
<i>Fixed Effects</i>	
Intercept	1.72*** (0.06)
State (1=ME)	0.19** (0.06)
Teacher Experience	0.01 (0.02)
SES	-0.01*** (0.001)
Prior knowledge	0.004 (0.005)
Format=simulation	0.76*** (0.05)
Format=scenario	-0.08 ⁺ (0.05)
Topic=energy drinks	0.35*** (0.06)
Topic=asthma	0.003 (0.06)
Topic=video games	0.43*** (0.06)
Topic=volume level	0.11* (0.06)
Topic=healthy snacks	0.01 (0.06)
Topic=smoking	0.15** (0.06)
Topic=contacts	0.27*** (0.06)
<i>Fixed Effects</i>	
Hedges' g for state	0.15

Note: Numbers in parentheses are standard errors. All models are based on 41 schools and 1085 students. All non-dummy variables (i.e. SES, teacher experience, prior knowledge) are grand mean centered. ⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Validation Study Research Question 2

Results of the multilevel multivariate HLM model predicting the overall performance of students on the ORCA assessments while conditioning on important covariates are presented in the first column of Tables 4.15 and 4.16. Table 4.15 excludes the prior knowledge covariate, whereas table 4.16 includes this covariate. Offline reading measures (ORMS) appear in both tables for the current study. They were not included in the replicated study.

The results found in Tables 4.15 and 4.16 provide evidence that membership in a state (Maine) with a one-to-one laptop policy had a positive impact on students' online research and learning. The results found in the first column of Tables 4.15 and 4.16 are estimates of the average relationship between the independent variables and ORCA scores after conditioning on the other variables in the model. After accounting for the differences between Maine and Connecticut with respect to the important covariates, unlike in the pilot study, a positive association between residency in Maine and ORCA scores was not found. This association was consistent across both models (with and without Prior Knowledge as a covariate) and was not statistically significant in either model.

Table 4.15

Multivariate multi-level models excluding prior knowledge – Validation Study

Outcome	All
<i>Fixed Effects</i>	
Intercept	0.81 ^{***} (0.13)
State (1=ME)	-0.07 (0.08)
Teacher Experience	-0.002 (.004)

SES (% FRL)	-0.003 ⁺ (.002)
Offline Reading Measure	0.11 ^{***} (.006)
Topic=energy drinks	0.36 ^{***} (0.05)
Topic=video games	0.29 ^{***} (0.05)
Topic=healthy snacks	0.13 ^{***} (.006)

Fixed Effects

Hedges' g for state	-0.11
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Note: Numbers in parentheses are standard errors. All models are based on 40 schools and 1,377 students. All non-dummy variables (ie. SES, teacher experience) are grand mean centered.⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Table 4.16

Multivariate multi-level models including prior knowledge – Validation Study

Outcome	All
<i>Fixed Effects</i>	
Intercept	0.51 ^{***} (0.14)
State (1=ME)	-0.06 (0.08)
Teacher Experience	-0.002 (.004)
SES	-0.003 (.002)
Offline Reading Measure	0.11 ^{***} (.006)
Prior knowledge	0.08 ^{***} (0.01)
Topic=energy drinks	0.29 ^{***} (0.05)
Topic=video games	0.29 ^{***} (0.05)
Topic=healthy snacks	0.07 (0.05)
<i>Fixed Effects</i>	
Hedges' g for state	-0.11

Note: Numbers in parentheses are standard errors. All models are based on 40 schools and 1,377 students. All non-dummy variables (i.e. SES, teacher experience, prior knowledge) are grand mean centered. ⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .$

Supplemental Analysis for Research Question 2

After completing the above analysis for research question #2, it became apparent that the current analysis was insufficient. To get a better understanding of the ORCA results a comparison of year 3 and year 4 data with the exact same set of covariates is necessary. Year 3 analysis did not include offline reading measures and included all three ORCA formats and all eight ORCA topics. Year 4 analysis included offline reading measures and only one ORCA format (ORCA-Simulated) and four topics. Therefore, an additional analysis was completed to compare year 3 and year 4 data with the exact same covariates considered excluding offline reading measures and only using ORCA-Simulated data with the four corresponding topics for both year 3 and year 4 data.

Results of a supplemental multilevel multivariate HLM model predicting the overall performance of students on the ORCA assessments while conditioning on important covariates are presented in Tables 4.17 and 4.18 for the pilot study (year 3 data) and in Tables 4.19 and 4.20 for the replication study (year 4 data).

Table 4.17

Multivariate multi-level models excluding prior knowledge – Pilot Study

Outcome	All
<i>Fixed Effects</i>	
Intercept	18.78*** (0.06)
State (1=ME)	0.16 (0.14)
Teacher Experience=1	-1.18 (0.09)
Teacher Experience=2	-0.15 (0.01)
Teacher Experience=3	-0.89 (0.07)
Teacher Experience=4	0.65 (0.04)
SES (% FRL)	-0.09*** (.01)

Topic=energy drinks	2.94** (0.12)
Topic=video games	1.02 (0.07)
Topic=healthy snacks	0.14 (0.01)

Fixed Effects

Hedges' g for state	0.13
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Note: Numbers in parentheses are standard errors. All models are based on 41 schools and 1085 students. All non-dummy variables (i.e. SES, teacher experience) are grand mean centered. ⁺= $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Table 4.18

Multivariate multi-level models including prior knowledge – Pilot Study

Outcome	All
Fixed Effects	
Intercept	18.68*** (0.07)
State (1=ME)	0.19 (0.17)
Teacher Experience=1	-1.17 (0.08)
Teacher Experience=2	-0.13 (0.01)
Teacher Experience=3	-0.89 (0.07)
Teacher Experience=4	0.65 (0.04)
Prior Knowledge	0.02 (0.01)
SES (% FRL)	-0.09*** (.01)
Topic=energy drinks	2.92* (0.12)
Topic=video games	1.44 (0.09)
Topic=healthy snacks	0.12 (0.007)
Fixed Effects	
Hedges' g for state	0.14

Note: Numbers in parentheses are standard errors. All models are based on 41 schools and 1085 students. All non-dummy variables (i.e. SES, teacher experience) are grand mean centered. ⁺= $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Table 4.19

Multivariate multi-level models excluding prior knowledge – Validation Study

Outcome	All
<i>Fixed Effects</i>	
Intercept	7.687*** (0.13)
State (1=ME)	-0.04 (0.10)
Teacher Experience	-0.02*** (.005)
SES (% FRL)	-0.02*** (.002)
Topic=energy drinks	1.33*** (0.13)
Topic=video games	1.14*** (0.13)
Topic=healthy snacks	0.37** (0.12)
<i>Fixed Effects</i>	
Hedges' g for state	-0.09

Note: Numbers in parentheses are standard errors. All models are based on 40 schools and 1,377 students. All non-dummy variables (ie. SES, teacher experience) are grand mean centered.⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Table 4.20

Multivariate multi-level models including prior knowledge – Validation Study

Outcome	All
<i>Fixed Effects</i>	
Intercept	5.089*** (0.18)
State (1=ME)	-0.01 (0.09)
Teacher Experience	-0.02 (.005)
SES	-0.01 (.002)
Prior knowledge	0.53*** (0.03)
Topic=energy drinks	0.92*** (0.02)
Topic=video games	1.16*** (0.12)
Topic=healthy snacks	-0.03 (0.2)
<i>Fixed Effects</i>	
Hedges' g for state	-0.09

Note: Numbers in parentheses are standard errors. All models are based on 40 schools and 1,377 students. All non-dummy variables (i.e. SES, teacher experience, prior knowledge) are grand mean centered. ⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .$

The results found in Tables 4.17, 4.18, 4.19 and 4.20 provide additional and confirming evidence that membership in a state (Maine) with a one-to-one laptop policy had a positive impact on students' online research and learning during the pilot year but not in the replication year. Similar patterns were seen across the covariates in this supplemental look at the data.

Summary and Comparison of Results for Research Question 2

Covariates in the analysis for research question #2, that previous research indicated would likely correlate with online learning performance, followed a similar pattern in the validation study results as they did in the pilot study. The analysis included the three covariates from the pilot study (socioeconomic status, prior domain knowledge of the topic, and teaching experience) plus a measure of offline reading. A relationship between ORCA Total scores and socioeconomic status, that favored students in Connecticut, was found but only when not-including prior knowledge in the analysis. Also found was a significant relationship between ORCA Total scores and prior domain knowledge of the topics favoring students in Connecticut, with a small to moderate effect size. No significant difference was found between ORCA Total scores and teaching experience between the two states. A significant difference was found between ORCA Total scores and offline reading that favored students in Connecticut, with a large effect size.

The results from the pilot study provide clear evidence that the one-to-one laptop policy in Maine had a positive impact on students' online reading and comprehension skills. Once the related covariates were accounted for differences between the states show a positive association between residency in Maine and ORCA scores. This association persists across both models

examined and is statistically significant in each model. While the effect size associated with state membership (between 0.14 and 0.15) would not typically be considered large, recent work has argued persuasively that effects of this magnitude in the middle school years are practically significant (Bloom, Hill, Rebeck, Black, and Lipsey, 2008).

The results from the validation study provide evidence that the one-to-one laptop policy in Maine had an impact on students' online research and learning skills, however, this difference was not statistically significant as it was in the pilot study and membership in Maine did not provide an overall advantage for the students. This may be true for several reasons including differences between the pilot and validation data regarding student laptop access, reported student time on task, and socioeconomic status (see further discussion of this finding in Chapter 5).

After conditioning on differences in the scores for the covariates, is there evidence of a higher mean score for any of the separate component scores of online research and learning (locate, evaluate, synthesize, communicate) for students in the state with a one-to-one computer policy?

Research question 3 in the replicated study used a multilevel multivariate HLM model to predict the overall performance of students on the ORCA assessments while conditioning on important covariates for the individual skill areas (locate, evaluate, synthesize, communicate). I was interested in knowing if the relationships between the independent variables and ORCA outcomes differ for the four different component skill areas for online research and learning. Research question 3 from the replicated study (year 3 data) was: "After conditioning on relevant covariates, is there evidence of higher average scores on the separate online research and learning components (locate, evaluate, synthesize, communicate) for students in the state with a

one-to-one laptop policy?” Research question 3 from the current study is nearly identical in its purpose to predict overall performance while still conditioning on important covariates for the individual skill areas. Research question 3 from the current study (year 4 data) asks: “After conditioning on differences in the scores for the covariates, is there evidence of a higher mean scores on an assessment of online research and learning (for each individual ORCA Total component locate, evaluate, synthesize, and communicate) for students in the state with a one-to-one computer policy?” To evaluate the effect of a one-to-one laptop policy after conditioning on the covariates that were identified, two separate HLM regression analyses were again completed. Both the replicated and current study examine the impact individual skill area scores as the dependent variable and indicator variable for state as an independent variable and two different sets of covariates.

Pilot Study Research Question 3

Results of the multilevel multivariate HLM model predicting the overall performance of students on the ORCA assessments while conditioning on important covariates are presented below in Tables 4.21 and 4.22. Table 4.21 excludes the prior knowledge covariate, whereas table 4.22 includes this covariate.

The results found in Tables 4.21 and 4.22 provide evidence that membership in a state (Maine) with a one-to-one laptop policy had a positive impact on students’ online research and learning. The results found in the four columns of Tables 4.21 and 4.22 are estimates of the average relationship between the independent variables and ORCA scores. After accounting for the differences between Maine and Connecticut with respect to the important covariates, the positive relationship between residence in the one-to-one laptop state and ORCA outcomes appear much stronger for the locate score dimension (0.31) than for any of the other three

dimensions (evaluate=0.11, synthesize=0.14, communicate=0.17). Only differences in locate and communicate were significant at the $p < .05$ level. While the effect size on the locate dimension (0.24) would be considered small by Cohen's (1988) standards, it is larger than the overall effect size of 0.15 reported in the previous section for the ORCA Total score overall.

Table 4.21

Multivariate multi-level models excluding prior knowledge – Pilot Study

Outcome	Locate	Evaluate	Synthesize	Communicate
<i>Fixed Effects</i>				
Intercept	2.10*** (0.10)	1.09*** (0.08)	2.82*** (0.09)	0.91*** (0.08)
State (1=ME)	0.31*** (0.08)	0.11 ⁺ (0.06)	0.14 ⁺ (0.07)	0.17* (0.07)
Teacher Experience	0.01 (0.03)	-0.005 (0.02)	0.02 (0.02)	0.02 (0.02)
SES (% FRL)	-0.01*** (0.002)	-0.01*** (0.001)	-0.01*** (0.002)	-0.01*** (0.002)
Format=scenario	0.31*** (0.08)	1.12*** (0.06)	0.007 (0.07)	1.61*** (0.06)
Format=simulation	-0.42*** (0.08)	-0.01 (0.06)	0.05 (0.07)	0.05 (0.06)
Topic=energy drinks	0.51*** (0.09)	0.30*** (0.08)	0.42*** (0.08)	0.13 ⁺ (0.08)
Topic=asthma	-0.03 (0.09)	-0.11 (0.08)	-0.52*** (0.08)	0.67*** (0.08)
Topic=video games	0.24** (0.09)	0.51*** (0.08)	0.16 ⁺ (0.08)	0.82*** (0.08)
Topic=volume level	-0.21* (0.09)	0.37*** (0.08)	0.10 (0.08)	0.12 (0.08)
Topic=healthy snacks	-0.49*** (0.09)	0.22* (0.08)	-0.05 (0.08)	0.31*** (0.08)
Topic=smoking	0.06 (0.09)	-0.33 (0.08)	-0.12*** (0.08)	0.59*** (0.08)
Topic=contacts	0.10*** (0.09)	-0.26 (0.08)	0.17 ⁺ (0.08)	0.75*** (0.08)
<i>Fixed Effects</i>				
Hedges' g for state	0.24	0.08	0.11	0.13

Note: Numbers in parentheses are standard errors. All models are based on 41 schools and 1085 students. All non-dummy variables (i.e. SES, teacher experience) are grand mean centered. ⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Table 4.22

Multivariate multi-level models including prior knowledge – Pilot Study

Outcome	Locate	Evaluate	Synthesize	Communicate
<i>Fixed Effects</i>				
Intercept	2.11*** (0.10)	1.09*** (0.08)	2.82*** (0.09)	0.92*** (0.08)
State (1=ME)	0.31*** (0.09)	0.11 ⁺ (0.06)	0.15 ⁺ (0.07)	0.17* (0.07)
Teacher Experience	0.01 (0.03)	-0.005 (0.02)	0.02 (0.02)	0.02 (0.02)
SES	-0.01*** (0.002)	-0.01*** (0.001)	-0.01*** (0.001)	-0.01*** (0.002)
Prior knowledge	0.001 (0.007)	0.007 (0.006)	0.005 (0.007)	0.0004 (0.006)
Format=simulation	0.31*** (0.08)	1.11*** (0.06)	0.005 (0.07)	1.61*** (0.06)
Format=scenario	-0.42*** (0.08)	-0.01 (0.06)	0.05 (0.07)	0.05 (0.06)
Topic=energy drinks	0.51*** (0.09)	0.28*** (0.08)	0.41*** (0.08)	0.13 (.08)
Topic=asthma	-0.03 (0.09)	-0.12 (0.08)	-0.53*** (0.08)	0.67*** (0.08)
Topic=video games	0.24** (0.09)	0.51*** (0.08)	0.15 ⁺ (0.08)	0.82*** (0.08)
Topic=volume level	-0.21* (0.09)	0.36*** (0.08)	0.10 (0.08)	0.12 (0.08)
Topic=healthy snacks	-0.49*** (0.09)	0.20** (0.08)	-0.06 (0.09)	0.31*** (0.08)
Topic=smoking	0.05 (0.09)	-0.04 (0.08)	-0.13 (0.08)	0.59*** (0.08)
Topic=contacts	0.10 (0.09)	-0.03 (0.08)	0.17* (0.08)	0.75*** (0.08)
<i>Fixed Effects</i>				
Hedges' g for state	0.24	0.08	0.11	0.13

Note: Numbers in parentheses are standard errors. All models are based on 41 schools and 1085 students. All non-dummy variables (i.e. SES, teacher experience, prior knowledge) are grand mean centered. ⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Validation Study Research Question 3

Results of the multilevel multivariate HLM model predicting the overall performance of students on the ORCA assessments while conditioning on important covariates are presented below in Tables 4.23 and 4.24. Table 4.23 excludes the prior knowledge covariate, whereas table 4.24 includes this covariate. Offline reading measures (ORMs) appear in both tables for the current study. They were not included in the replicated study.

The results found in Tables 4.23 and 4.24 provide evidence that membership in a state (Maine) with a one-to-one laptop policy had a slightly negative impact on students' online research and learning. The results found in the four columns of Tables 4.23 and 4.24 are estimates of the average relationship between the independent variables and ORCA scores. After accounting for the differences between Maine and Connecticut with respect to the important covariates, the positive relationship between residence in the one-to-one laptop state and ORCA outcomes appear much stronger for the locate score dimension (0.15) for Maine students and the synthesize score dimension (-0.23) for Connecticut students. However, both are significant at only the $p < .10$ level. While the effect size on the synthesize dimension (0.19) would be considered small by Cohen's (1988) standards, it is larger than the overall effect size of 0.11 reported in the previous section for the ORCA Total score overall.

Table 4.23

Multivariate multi-level models excluding prior knowledge – Validation Study

Outcome	Locate	Evaluate	Synthesize	Communicate
<i>Fixed Effects</i>				
Intercept	0.43** (0.15)	0.83*** (0.16)	1.40*** (0.21)	0.66*** (0.15)
State (1=ME)	0.15 ⁺ (0.09)	-0.13 (0.10)	-0.23 ⁺ (0.13)	-0.01 (0.09)
Teacher Experience	-0.003 (0.005)	-0.009 ⁺ (0.005)	-0.002 (0.007)	0.001 (0.005)
SES (% FRL)	-0.005** (0.002)	0.001 (0.002)	-0.005 ⁺ (0.003)	-0.001* (0.002)
Offline Reading Measure	0.07*** (0.005)	0.10*** (0.004)	0.15*** (0.006)	0.13*** (0.006)
Topic=energy drinks	0.92*** (0.04)	0.003 (0.04)	0.90*** (0.05)	-0.38*** (0.05)
Topic=video games	1.24*** (0.04)	0.51*** (0.08)	-0.23*** (0.04)	-0.03 (0.05)
Topic=healthy snacks	0.67*** (0.04)	0.02 (0.03)	0.08 ⁺ (0.04)	-0.24*** (0.04)
<i>Fixed Effects</i>				

Hedges' g for state	0.06	-0.16	-0.19	-0.03
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Note: Numbers in parentheses are standard errors. All models are based on 40 schools and 1,377 students. All non-dummy variables (ie. SES, teacher experience) are grand mean centered.⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .001$

Table 4.24

Multivariate multi-level models including prior knowledge – Validation Study

Outcome	Locate	Evaluate	Synthesize	Communicate
<i>Fixed Effects</i>				
Intercept	0.17 (0.15)	0.57*** (0.16)	1.14*** (0.21)	0.22 (0.15)
State (1=ME)	0.16 ⁺ (0.09)	-0.12 (0.10)	-0.23 ⁺ (0.13)	0.006 (0.09)
Teacher Experience	-0.003 (0.003)	-0.009 ⁺ (0.005)	-0.002 (0.007)	0.001 (0.005)
SES	-0.005* (0.002)	0.001 (0.002)	-0.005 (0.003)	-0.003* (0.002)
Offline Reading Measure	0.07*** (.006)	0.09*** (0.004)	0.14*** (0.006)	0.11*** (0.006)
Prior knowledge	0.07*** (0.01)	0.07*** (0.008)	0.07*** (0.01)	0.12*** (0.01)
Topic=energy drinks	0.86*** (0.04)	-0.05 (0.04)	0.84*** (0.05)	-0.48*** (.05)
Topic=video games	1.24** (0.04)	0.17*** (0.03)	-0.23*** (0.05)	-0.03 (0.04)
Topic=healthy snacks	0.61*** (0.04)	-0.04** (0.04)	0.03*** (0.05)	-0.33*** (0.01)
<i>Fixed Effects</i>				
Hedges' g for state	0.06	-0.16	-0.19	0.03

Note: Numbers in parentheses are standard errors. All models are based on 40 schools and 1,377 students. All non-dummy variables (ie. SES, teacher experience, prior knowledge) are grand mean centered. ⁺ = $p < .10$; * = $p < .05$; ** $p \leq .01$; *** $p \leq .$

Supplemental Analysis for Research Question 3

After completing the above analysis for research question 3, just as in research question 2, it became apparent that the current analysis was insufficient. To get a better understanding of the ORCA results a comparison of year 3 and year 4 data with the exact same set of covariates is necessary. A supplemental analysis was performed, as was done in research question 2, but for locate, evaluate, synthesize, and communicate as opposed to ORCA Total scores. Results of the

supplemental multilevel multivariate HLM model predicting the overall performance of students while conditioning on important covariates resulted in the same pattern of results as seen from the supplemental analysis completed for research question 2.

Summary and Comparison of Results for Research Question 3

The results in each column of Tables 4.17-4.20 estimates the average relationship between the independent variables and ORCA individual skill areas (locate, evaluate, synthesize, communicate). The positive relationship between residence in the one-to-one laptop state and ORCA outcomes was stronger for the locate score than for any of the other three skill areas in the pilot study. While the effect size on the locate dimension (0.24) would still be considered small by Cohen's (1988) standards, it is substantially larger than the overall effect size of 0.15 reported in the previous section and would certainly be considered practically significant in the middle school years based on the benchmarks presented in Bloom et al. (2008). This positive relationship continues in the validation study but certainly not as strong as in the replicated study with a locate effect size of 0.06.

The positive relationship between residence in the one-to-one laptop state and ORCA outcomes was also strong for the synthesis skill area in the pilot study. In both the pilot and validation study results showed a significant difference between student groups on the synthesis tasks between the groups of students. Unlike the locate skill area, effect sizes for synthesis were stronger in the validation year as compared to the pilot year, however, they were still relatively low (0.19) and in the opposite direction (favoring) Connecticut versus Maine.

The skill areas of evaluate and communicate did not prove to be significantly different between states in the validation study. This was a change from the results of the pilot study in which both demonstrated significant differences, however, in both cases the effects sizes were

small for the pilot study (0.08 and 0.13 respectively). Offline reading scores, not included in the pilot study, but included in the current study, were shown to have a significant impact on ORCA total scores and individual skill area scores for both models. When analyzing each individual skill area, offline reading was shown to be significantly different between student groups in each skill area favoring students in Connecticut for each.

Is there a relationship between teacher practices used for student online research and learning success and ORCA performance as measured by teacher and student responses on Internet use surveys?

Research question #4 sought to evaluate a possible relationship between teacher instructional practices and student performance as measured by ORCA scores. Specifically, does time on task using the Internet impact student performance on online research and learning? This analysis was not conducted in the pilot study but was conducted in the validation study to expand our understanding of time on task to online research performance.

Confirmatory Analysis

The first analysis, a confirmatory analysis, was run between each identified survey question disaggregated by state. The analysis looked to confirm similarities between teacher and student responses on similar questions on both the teacher Internet use survey and student Internet use survey (see Figure 4.1 below). For each of the three student questions, responses by students in Maine were significantly higher than corresponding student responses in Connecticut. For each of the three teacher questions, responses by teachers in Maine for students were significantly higher than corresponding teacher responses for students in Connecticut (see Table 4.25).

Figure 4.1. Teacher and Students Questions from Internet User Surveys

Role	Question #	Question Text
Teacher	TIUS16	About how many days per month (out of 28 days) do you REQUIRE students to use the Internet for a school assignment?
Student	SIUS11	For your English Language Arts class, about how many days per month (out of 28 days) do you work on assignments where your teacher REQUIRED you to use the Internet?
Teacher	TIUS17	About how many days per month (out of 28 days) would you estimate that students CHOOSE to use Internet for a school assignment?
Student	SIUS12	For your English Language Arts class, about how many days per month (out of 28 days) do you work on assignments where you CHOOSE to use the Internet, even though it is not required?
Teacher	TIUS19	On average, about how much time EACH DAY do students use the Internet in each of your classes?
Student	SIUS18	On average, about how much time EACH DAY do you use the Internet at school?

Table 4.25

Means, SDs, and Sample Size by State regarding time on Internet task questions from the Student and Teacher Internet Use Surveys

	Connecticut			Maine			Total		
	Mean	SD	Total	Mean	SD	Total	Mean	SD	Total
<i>Teacher: Days per Month (Required)</i>	4.54	4.42	24	14.92*	5.34	26	9.94	7.15	50
<i>Student: Days per Month (Required)</i>	5.17	6.22	695	11.48*	8.25	637	8.18	7.92	1332

<i>Teacher:</i>	7.88	6.72	24	18.69*	7.72	26	13.50	9.02	50
<i>Days per Month (Choose)</i>									
<i>Student:</i>	4.54	6.44	695	9.16*	8.30	637	6.75	7.74	1332
<i>Days per Month (Choose)</i>									
<i>Teacher:</i>	19.29	30.31	24	47.35*	32.66	26	33.88	34.29	50
<i>Time each Day</i>									
<i>Student:</i>	62.85	83.96	695	165.47*	95.69	637	111.92	103.35	1332
<i>Time each Day</i>									

Note: Significant differences between two states * = $p < .05$.

Table 4.26 presents the analysis for the student item: “Do you have your own laptop that you use at school and home?” on the student Internet use survey. Over three quarters of Maine students have access to a laptop in the classroom and at home while only 35% of Connecticut students have the same access.

Table 4.26

Results of Chi-Square Test and Descriptive Statistics for Student Laptop Access in the Classroom and at Home by State as Reported by Students

Question	Do you have your own laptop that you use at school and home? (Yes/No)	
	Yes	No
Connecticut	244 (35%)	451 (65%)
Maine	482 (76%)	155 (24%)

Table 4.27 presents the analysis for the teacher item: “Which of the following best describes your students’ individual access to a computer/laptop/iPad/netbook, etc. During your

English Language Arts class?” on the teacher Internet use survey. Chi-square test of independence results show a statistically significant relationship ($X^2 = 37.0^*$, $df = 4$, $p < .000$) in student access to laptops within the classrooms of the two states.

Table 4.27

Results of Chi-Square Test and Descriptive Statistics for Student Laptop Access in the English Language Arts Classroom by State as Reported by Teachers

Question	Which of the following best describes your students’ individual access to a computer/laptop/iPad/netbook, etc. During your English Language Arts class?				
Answer	Never	Rarely	Sometimes	Often	Always
Connecticut	2 (8.3%)	6 (25.0%)	14 (58.3%)	2 (8.3%)	0 (0.0%)
Maine	0 (0.0%)	0 (0.0%)	2 (7.7%)	6 (23.1%)	18 (69.2%)

Correlation Analysis

The second analysis, a correlation analysis, was run across corresponding questions between the teacher and student surveys also disaggregated by state. The correlation analysis looked to confirm consistency between teacher and student responses by finding a strong and positive connection between teacher and students responses. Teacher and student reports of required Internet use in Maine were not significantly correlated.

Teacher and student reports of required Internet use in Connecticut were significantly correlated, $r = .137$, $p < .01$. Teacher and student reports of Internet use by choice in Maine were not significantly correlated, $r = .032$. Teacher and student reports of Internet use by choice in Connecticut were significantly correlated, $r = .087$, $p < .05$. Teacher and student reports of time on Internet use in Maine were significantly correlated, $r = .104$, $p < .01$. Teacher and student reports of time on Internet use in Connecticut were not significantly correlated, $r = -.026$.

Teacher and student reports of access to laptops in Connecticut were not significantly correlated,

$r = .045$. Teacher and student reports of access to laptops in Maine were significantly correlated, $r = .222, p < .01$. Results have been summarized in Table 4.28.

Table 4.28

Summary of Correlation Analysis Between Teacher and Student Responses

Significant Correlation Between Teacher and Student Responses		
Question	Connecticut	Maine
Internet Use Required	Yes $r = .137, p < .01$	No $r = .032$
Internet Use Chosen	Yes $r = .087, p < .05$	No $r = .023$
Time On Internet	No $r = -.026$	Yes $r = .104, p < .01$
Laptop Access	No $r = .045$	Yes $r = .222, p < .01$

Predicting ORCA Total Scores from SIUS Questions

The third analysis, using multilevel hierarchical linear modeling, predicted the increase (or decrease) in ORCA Total scores associated with an additional day that a student chooses to use the internet for a school assignment (SIUS12) after we take in to account the number of days his/her teacher requires him/her to use the internet(SIUS12) and the amount of time the student reports time on task for each day (SIUS18). Results show that of the three, only the days required by teachers to use the Internet predict an increase in ORCA Total score for a student (Beta = 0.072) while the number of days chosen to use the Internet by the student (Beta = -0.008) and time on task (Beta = -0.135) predict a decrease in ORCA Total scores. After adjusting for the nested nature of the data, significance levels were only reached for the time on task variable (adjusted $p < .000$) not for required days (adjusted $p < .06$) or chosen days (adjusted $p < .883$). A similar pattern was seen when looking at similar results by each individual state. However,

Maine students report of the number of days they chose to use the Internet predicted an increase in ORCA Total scores where the Connecticut students followed the overall pattern of days chosen predicting a decrease in the ORCA Total score. Neither of these results reached a significant level.

Summary of Results for Research Question 4

All measures of time on task, as defined by the three question each on the student and teacher Internet use surveys respectively, showed significant differences between the states. In all cases, both teachers and students from Maine reported statistically significant higher time on task rates for Internet use. In addition, both teachers and students reported significantly higher rates of access to laptops in the classroom for Maine students versus Connecticut students. The results from these confirmatory items indicate that the year 4 sample contained classrooms from Connecticut where students had far less access to their own laptops and from Maine where students had far greater access. They also indicate that students in Maine chose to use their laptops for assignments above and beyond when required to use the Internet when not mandated by a teacher significantly more frequently than students in Connecticut.

When comparing the responses of teachers versus students in each state separately for consistency, many inconsistencies in the responses were found. Regarding days required to use the Internet, Maine responses from teachers and students were not correlated significantly, yet Connecticut responses were correlated significantly, however, the relationship is weak ($r = .137$). Regarding days chosen to use the Internet, Maine responses from teachers and students were not correlated significantly, yet Connecticut responses were correlated significantly but again the positive relationship is weak ($r = .087$). Regarding time on the Internet, Connecticut responses from teachers and students were not correlated significantly, yet Maine responses were correlated

significantly ($r = .104$). Regarding access to laptops, Connecticut responses from teachers and students were not correlated significantly, yet Maine responses were correlated significantly ($r = .222$).

A relationship was indeed found between teacher practices used for student online research and learning success and ORCA performance as measured by teacher and student responses on Internet use surveys. However, because of the inconsistencies in the correlation of responses across both states firm conclusions cannot be drawn from these findings and more study is necessary.

The predictive nature of the identified survey questions were inconclusive. None of the responses were able to predict ORCA Total scores at a significant level. There is some evidence that the days required by a teacher to use the Internet for assignments is related to an increase in ORCA Total scores. However, taken together with the lack of consistency of responses between students and teachers from the correlation analysis above, there is insufficient evidence to draw any conclusions.

Analyses for Supplemental Inquiry

During the analysis of data for the validation study, it was identified that additional analyses were needed to compare year 4 data from the validation study with year 3 data that were not reported in the pilot study. The reason for this was twofold. One, the pilot study data included data based on all three formats whereas the validation study only looked at one format. Two, the pilot study data included data based on eight subject areas whereas the validation study only looked at four subject areas.

Table 4.29 includes ORCA total mean scores for Connecticut and Maine students that took the ORCA-Simulated format. ORCA total results were reported in the pilot study including

all three formats (ORCA-Open, ORCA-Simulated, ORCA-Scenario). ORCA total results for this validation study only included ORCA-Simulated results. Table 4.29 provides a direct comparison of year to year results for only ORCA-Simulated score point totals.

Table 4.29

ORCA Total Averages Pilot Year versus Validation Year – ORCA-Simulated

	Pilot Study	Validation Study
Connecticut	8.10	7.42
Maine	7.46	7.04

Notes. All averages represent raw scores not scores conditioned for correlates.

In addition, ORCA-Simulated totals from the pilot study using year 3 data included all 8 subject areas. ORCA-Simulated for both the pilot and validation study only used four of the eight total subjects. The pilot study never reported ORCA totals by subject area. Table 4.30 below represents the mean ORAC total scores for all students from both states who competed the ORCA-Simulated format in each of the four subject areas.

Table 4.30

Comparing ORCA-Simulated ORCA Total Scores for All Students

	Pilot Study			Validation Study			Sig.
Subject	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i> -value
Energy Drinks	107	8.75	3.102	333	7.85	3.199	2.584*
Video Games	98	8.45	3.365	340	7.71	3.637	1.804+
Healthy Snacks	89	7.46	3.053	369	6.91	3.219	1.476
Contacts	94	8.13	3.122	335	6.53	3.222	4.289*
Total	388	8.23	3.188	1377	7.24	3.364	5.163*

Note. *M* = mean; *SD* = standard deviation. Significance at .05 level. * $p < .05$. Significance at .10 level. + $p < .10$.

Summary of Results Overall

In this chapter, results were presented for the quantitative analysis that sought to answer the four research questions in this study, three of which were nearly identical to the research questions found in the replicated study. The results of the analysis suggest results from the year 4 validation study sample, while similar in most ways to the sample from the year 3 pilot study, did not demonstrate the same clear and significant level of evidence that the one-to-one laptop policy in Maine had a positive impact on students' online research and learning skills. In the following chapter I will discuss the impact significant changes in many of the relevant co-variates and correlated variables may have found in the outcome of the current validation study.

CHAPTER 5

DISCUSSION

Introduction

This study sought to investigate how effectively students in two states, one with (Maine) and one without (Connecticut) a state-wide one-to-one laptop program, performed on measures of online research and learning in science. This study replicated and extended the findings of a recent study (Kennedy et al., 2016) using a more current and more extensive data set. In general, this study adds to the body of research looking specifically at the integration of Internet-based technology into teaching and student learning (Leu et al., 2015; Lankshear & Knobel, 2011; Greenhow et al., 2009; Jonassen, Howland, Moore & Marra, 2002). Additionally, this study examined the extent to which several important individual differences affect students' ability to perform online research in science.

A one-to-one computing model in schools, which helps provide access to online information for learning anywhere anytime, is an important recent development in education (Argueta et al., 2011; Warschauer, 2007; Zucker & Light, 2009). Previous studies of the effects of one-to-one initiatives have not been especially well designed (often relying solely on self-report and offline high-stakes state test data) and have neglected to directly evaluate students' ability to learn from online information. This study, and the replicated study before it, used an innovative, performance based assessment, where students were required to complete online research and learning tasks. Tasks were situated in the science domain because learning from online information is an important aspect of disciplinary literacy in this particular subject area (see Achieve, 2013; Australian Curriculum Assessment and Reporting Authority, n.d.). The replicated (pilot) study and this current (validation) study are the first to use a representative

sample of the population from two states and to use an outcome measure closely tied to the type of learning one might expect from laptop use in and out of the classroom.

The overall findings of this study are below. The following sections will expand and explain these arguments:

- In the pilot study, using year 3 pilot data, it was found that after conditioning on important potential confounding variables, there was a significant difference in students' ability to perform research and learn from online information favoring students in the one-to-one laptop state (Maine). In this validation study, using year 4 data, similar patterns were seen in the results however they slightly favored Connecticut (as opposed to Maine) and the overall result was not found to be significant.
- It was found that students continued to perform poorly overall in all skill areas (locate, evaluate, synthesize, communicate) in the current validation study which matches findings from the replicated pilot study.
- In the pilot study, using year 3 pilot data, it was found that the difference in self-reported data from teachers and students regarding access to laptops in the classroom was profound (100% access in Maine and 0% access in Connecticut). This finding changed in this validation study using year 4 data (76% access in Maine and 35% access in Connecticut). It is not clear as to why we see such a dramatic change from one year to the next. This could be due to different wording of the Internet use survey questions and/or the laptop access in the unique school districts assessed between years 3 and 4.
- It was found that considerable discrepancies exist between the reporting of teachers and students' beliefs on their respective Internet use surveys. There were strong correlations found between Maine teachers and students on the questions of Internet time on task in

the classroom and access to laptops, but no correlation found between Connecticut teachers and students on these questions. There were correlations found between Connecticut teachers and students on the questions of required Internet use and students choosing to use the Internet in the classroom, but no correlation found between Maine teachers and students on these questions. The discrepancies in these findings lead to the conclusion that the predictive results of the analysis from the identified Internet use survey questions do not provide adequate actionable evidence.

Research Question 1

Research question 1 sought to confirm statistical results of important correlates. One of the most important difference found between the pilot study and this current validation study was in regards to student access to laptops. The pilot study made a strong argument that a systemic, across-the-state one-to-one laptop program was directly related to the student outcomes on the ORCA measure of online research and learning. Results showed a strong relationship between state and ORCA scores once other covariates were addressed. In the validation study, Connecticut students performed better overall yet Maine students performed better once socioeconomic status, prior knowledge, offline reading measures and teacher experience were included as covariates in only one of the ORCA areas (locate) and not for the overall ORCA total as was seen in the pilot study.

Laptop Access

In the pilot study analysis, the teacher and student surveys confirmed that students in Maine all had access to laptops in the classroom while none of the Connecticut students had access. In the current validation study, this changed showing a much smaller difference between states with Maine teachers and students reporting only 76% access to laptops and a large increase

from Connecticut teachers and students reporting 35% access. This discrepancy appears to signal that Connecticut schools are taking access to laptops more seriously for their students and could certainly account for some if not all the differences found in the validation study.

The difference in reported student access to laptops in Maine, between the pilot year and validation year, runs counter to the publically reported state information on the Maine middle school 1to1 laptop initiative. Maine reported that 100% of middle school (N=226) in the state were part of the 1to1 program (Maine Learning Technology Initiative, 2010). Several explanations appear to exist as to why we saw a large drop in the Maine responses. One, in the pilot study only teacher responses were used to answer the question of access. During the validation study, both teachers and student response were used. The teacher response seems to confirm the pilot year data (students had access to laptops sometimes, often or always 100% of the time) but the students' responses used in the analysis were not asked for during the pilot year thus a comparison cannot be made. Two, some school districts updated their usage fee policy. If students wanted to keep their laptops at school, they were not responsible for the \$50 usage fee (K-12 Blueprint, 2015). Because the survey question specifically asked if students had access to the laptop at school and at home they may have answered in the negative because many of them may have opted to not pay the fee and thus not bring the laptop home. Three, the language in the question ask "do you have your own laptop" which could be interpreted as a personal laptop paid for by the family as opposed to a school laptop that is purchased by the school district for the student to use and not own.

Overall, Maine students continued to perform better after conditioning on important correlates in only one area of the ORCA but not significantly overall. It should be noted, however, that the self-report data regarding laptop access between Maine teachers and students

was significantly correlated whereas the self-report data for laptop access between Connecticut teachers and students was not (see the discussion of Research Question 4 below). This brings into question the 35% statistic reported by Connecticut students regarding their access to laptops. Although, in the Chi-square analyses for teacher-to-teacher and student-to-student differences between the two states respectively, a significant relationship in access to laptops did appear (see tables 4.2 and 4.3).

It may also be the case that Connecticut saw a surge in student access to laptops beginning in the 2012-2013 school year, the year in which validation study data were collected. The Smarter Balanced Assessment Consortium began running their Smarter Balanced Assessment Consortium (SBAC) pilot tests in 2013 in school districts in all consortium states including Connecticut. The SBAC is an adaptive assessment requiring students to complete the test using an Internet connected digital device typically a laptop or tablet. SBAC testing was expanded in the following year to prepare all districts for the first operational SBAC test in 2015 (Regents of the University of California, 2017). Connecticut schools may have seen a surge in student access to laptops as districts around Connecticut invested in additional digital devices to meet the administration requirements of the SBAC test.

Required Internet Use

In addition to differences in access to laptops, this study was also able to confirm an increase in the days that teachers required students to use the Internet for classroom assignments. In the pilot study, 5% of Connecticut teachers reported that they required the use of the Internet once per week, 40% reported once per month, 40% reported a few times per year or less, and 15% reported no requirement at all. In total, approximately 95% of Connecticut teachers required the use of the Internet one week per month or less. The validation study data showed

that Connecticut teachers reported that, on average they required classroom use of the Internet over 4.5 days per month. This increase may explain some of the overall differences found state versus state on ORCA scores for the validation study.

In the pilot study, fewer than 40% of teachers from Maine reported requiring the use of the Internet more than once a week and nearly 30% reported requiring Internet use just once a month in the pilot study. In the validation study, evidence suggests an increase to an average of almost 15 days per month for all Maine teachers. Teacher reports about the frequency with which the Internet was required for assignments suggest that the laptops in the classrooms of Maine may not have been used as extensively as they could have been to accomplish learning tasks with online information. While the possibility certainly exists that initial skills were still being developed with laptops for students in their first year of one-to-one access (Maine issues new laptops to grade 7 students each year), one wonders if usage rates at these levels imply that teachers are not taking full advantage of one-to-one computing for learning from online information.

Socioeconomic Status

Only small changes occurred between the sample population average SES levels between states from the pilot to the validation study. During both years, Maine had a substantial and significantly higher rate of students who qualified for the U.S. federal government free and reduced lunch program compared to Connecticut.

Leu et al. (2015) found a significant and substantial difference in online research and learning between students in economically advantaged and economically challenged school districts, neither of which had one-to-one programs. The difference, favoring students in an economically advantaged district, appeared even after conditioning on scores in state reading and

writing assessments. The results from the pilot study supports the notion that a one-to-one laptop program has the potential for mitigating this socioeconomic gap. The results from the validation study, however, do not support this argument.

Prior Knowledge

In the pilot study, student prior scientific knowledge was significantly different between the two states ($t = 2.56$, $df = 39$, $p = .017$). In this validation study, a statistically significant difference was also found between students in each state ($t = 2.56$, $df = 1375$, $p = .017$), however, when comparing the two states at the school level versus the student level, there was not a significant difference ($t = 1.57$, $df = 38$, $p = .123$). Overall, learning is profoundly influenced by prior knowledge (Kintsch, 1998; McNamara & Kintsch, 1996; Voss & Silfies, 1996). However, other studies have found prior knowledge to not be significant (Coiro, 2011; Leu et al., 2015) and for the purposes of this study it does not appear to be a factor in the final outcome.

Teacher Experience

Although teacher experience is typically considered an important part of instructional efficacy in the classroom (Darling-Hammond, 2000; Rivkin, Hanushek, & Kain, 2005), in both the pilot and current studies, it was found that teacher experience was not significantly different between the states and had no significant impact on student ORCA performance when included in the analyses for research question 2 and 3. It must also be noted again that teachers were selected at each school by their principal, rather than by randomization. This approach was useful to maintain good relationships with school partners. Principals were not aware that their state would be compared with another state and we have no reason to believe that any systematic bias occurred in the selection of teachers in one state over the other.

ORCA Scores

Clearly, the overall low level of performance in online research and learning in both studies suggests that there is substantial room for improvement in these skills areas among students in the two states regardless of participation in a one-to-one laptop program. All students in the pilot year on average were able to successfully answer just over 50% of ORCA questions. Students in this validation year were able to successfully answer on average just under 50% of ORCA questions. Performance at this level, on an online research and learning task that was guided by a student avatar, implies that most students could not successfully conduct independent online research and learning in science. These results are similar to those found in Leu et al., 2015. The generally low level of performance may suggest that the results found in this study may be limited to performance patterns at this level. Additional research at all levels of performance will be required to evaluate this possibility. The overall low level of performance may also suggest an issue for schools in the United States since students from several countries who participated in the aforementioned IEA study (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2013) appeared to perform at reasonable levels on informational literacy tasks. However, students in the United States did not participate in that study. One explanation of continued poor performance overall in the current study could be due to the selection of only scores from the ORCA-Simulated. Based on the pilot study, ORCA-Simulated had the lowest average score on the three formats used. This would not help explain difference by states, however, it could explain the continuation of low overall scores even after another year of school awareness of the need of online research and learning.

Also, additional analyses were conducted on the pilot data set that was not part of the original study (see Tables 4.29 and 4.30). When analyzing only ORCA-Simulated scores and

removing cases for the other two formats, overall ORCA performance improves for both Connecticut and Maine students.

Research Question 2

In the pilot study, with the conditioning of important potential confounding variables, it was found that there was a significant difference in students' ability to learn from online information favoring students in the one-to-one laptop state (Maine). While the effect size associated with state membership (between 0.14 and 0.15) would not typically be considered large, recent work has argued persuasively that effects of this magnitude in the middle school years are practically significant (Bloom, Hill, Rebeck, Black, and Lipsey, 2008). In the validation study, with the conditioning of important potential confounding variables including offline reading measures, it was found that there was not a significant difference in students' ability to learn from online information favoring students in the one-to-one laptop state (Maine). Although these results are counter to what was hypothesized in the proposal for this study, other findings as well as changes in the ORCA instrument use in this study may account for or contribute to a lack of validation of the findings in the replicated study.

The most obvious change in the findings that could account for the difference in results between studies is the number of laptops accessible to students in the classroom. In the replicated study these numbers were very clear. All Maine students had access and none of the Connecticut students had access. In the current study, we see a very different story regarding access. Nearly 35% of Connecticut students now had access, combined with a significant increase in reported days that teachers required the use of the Internet for classroom work. In Maine, evidence appears to demonstrate a decrease in laptop access in the classroom by almost 25%.

The other obvious change in the findings that could account for the difference in the results between studies is the time on task required by teachers for students to perform Internet related tasks. Teachers and students in Maine and Connecticut reported increases in days and time required for Internet related tasks from the replicated to the current study. However, the Connecticut gains are not surprising in the current study when taking into consideration that 95% of Connecticut teachers reported required use of the Internet once per month or less in the replicated study and required use approximately 4.5 days per month in the current study. As mentioned, teachers in Maine also reported an increase year over year, however, in the replicated study over 71% of Maine teachers were already reporting that they required the use of the Internet for related tasks once or more than once per week.

In addition, the significant differences between SES in states may suggest a far more disconcerting issue. It is possible that wealthier districts will inadvertently increase the achievement gap for online research and learning if they continue to implement one-to-one laptop programs faster than less wealthy districts that cannot afford one-to-one programs. Given the current costs of implementation, a new digital divide (based on skills and abilities not just access to digital hardware) is more likely than not as richer districts continue to demonstrate the will and budget to provide greater laptop access. It would certainly be ironic if wealthier districts rely on the results of this study as a rationale for implementing one-to-one programs while poorer districts are unable to do so for budgetary reasons.

Research Question 3

Performance by the students in the two states on the four different components of online research were evaluated separately after conditioning on important correlates. Overall, in the pilot study, Maine students performed significantly better than Connecticut students in each

skills area (locate, evaluate, synthesize, communicate). The effect size associated with residence in Maine in the pilot study was much higher for locating online information relative to the other three skills in the replicated study (see Table 4.21). This effect was highly statistically significant.

No data were obtained to suggest why locating online information was the area in which students in the two states seemed to differ the most in both the pilot and validation studies. We can only speculate that this area may be a more frequent activity in classrooms in Maine versus Connecticut since one typically must locate information in any online learning task. Again, Maine students and teachers reported many more experiences in their classroom where they engaged in online research and learning in both the pilot and validation study with less of a difference in the validation study.

Another possibility is that other areas (evaluating, synthesizing, and communicating online information) may be more challenging to teach, and are taught less frequently, since they appear to reflect higher-order thinking skills. It may also be the case that professional development was lacking in the teaching of the other online research and learning skills since these are not often taught in the classroom (Leu et al., 2013). Indeed, it is common to invest in one-to-one initiatives without a commitment and sufficient investment in professional development in the use of these resources for online information use and learning (Zucker & Light, 2009). We can only speculate that there may be greater potential for one-to-one computing programs than evidenced in this study, once adequate professional development and support in the effective use of online information for research and learning is consistently provided to teachers.

Research Question 4

An analysis of additional questions from the expanded Internet use surveys, that were not available previously during the pilot study, yielded both expected and unexpected results regarding student and teacher reporting of Internet time on task. It was not surprising, based on results from the pilot study, that the validation study revealed that all measures of time on task from students and from teachers showed significant differences between the states favoring Maine. Maine teachers reported almost three times as many days requiring Internet tasks and Maine students reported almost 2.5 more time on Internet tasks as Connecticut teachers and students respectively (see Table 4.25).

When comparing the responses of teachers versus students within each state separately for consistency however, a less confident picture is painted. It was found that only in Maine was there consistency in self-reporting between teachers and students regarding the questions of Internet usage time and access to laptops. In Connecticut, teacher and student answers were not consistent in their responses on these items. However, it should be noted that the positive and significant correlations found were all relatively weak. In Connecticut, a more affluent state, many students have laptop access provided by a parent and attend schools with BYOD (bring your own device) programs. This may account for the inconsistencies between teacher and student responses where teachers are not aware of all personal student laptops being used while students may be including time on task on their personal laptops.

In addition, it was found that only in Connecticut is there consistency in reporting between teachers and students regarding the questions of Internet usage days both required and chosen by students. In Maine, teacher and student answers were not consistent in their responses on these items. Table 4.28 provides of summary of the correlation analysis completed to identify

these inconsistencies and includes r values that demonstrate the weak nature of the significant correlations found.

The predictive nature of the identified survey questions were also inconclusive. None of the responses were able to predict ORCA Total scores at a significant level. Evidence exists that the days required by a teacher for students to use the Internet for assignments is related to an increase in ORCA Total scores. However, taken together with the lack of consistency of responses between students and teachers from the correlation analysis above, as well as the disparities in laptop access across the identified sample, there is insufficient evidence to draw any conclusions that can be helpful to classroom teachers.

Overall Results

Perhaps just as important as the finding that students in laptop programs typically score higher, on average, compared to students without access to laptops (after conditioning on covariates) was the discovery that across both states students, on average, students could successfully only complete slightly more than 50% of the tasks required by the pilot study (see tables 4.11 and slightly below 50% in this validation study (see Table 4.12). Although today's students grow up in an online world and are developing skills in diverse areas such as gaming, social networking, video editing, and texting, this does not mean that they are necessarily proficiently skilled in online information use. Quite to the contrary, adolescents tend to overestimate their abilities online, perhaps deceived by their ability to engage successfully with online social networking, texting, and video games into thinking that these skills will translate to other domains (Kuiper, 2007).

It is my belief, informed by work on both the pilot study and this validation study, that students must be able to perform at an adequate level with online inquiry to ensure their ability to learn

from online information. Results from the pilot study and from this validation study demonstrate students from two different states continue to perform poorly. Overall, both Maine and Connecticut students did perform marginally better on locate tasks. However, taken as a whole, if students are not able to evaluate the located information regarding the author or potential bias, if they are unable to synthesize the information with other located and relevant sources, and if they are unable to communicate these findings effectively, they will not be able to learn sufficiently from online information.

Replication Results

Based on representative samples of seventh grade students from two states, one with a statewide program (Maine) and one without (Connecticut), over the course of two studies in consecutive years, a significant difference between the two student groups that favored students in Connecticut, was found in the pilot study but not the current validation study. Although these results are surprising and unexpected, many contributing factors are believed to have led to the inability of this study to not replicate the overall findings of the replicated year 3 pilot study. The results, in context, do not suggest that laptops are unnecessary in schools, but that laptops and Internet access, alone, are insufficient for full preparation for today's world digital world.

So, what then explains a significant finding in the pilot study but not in the validation study? Similar findings regarding student prior knowledge and teachers experience in the two states persisted from the replicated to the current study. Overall, findings of socioeconomic status were consistent between the groups of students by state and by year. Findings regarding student access to laptops and required Internet related tasks are not similar between the two studies. As mentioned previously, the sharp decline of almost 50% between the pilot year and validation year in laptop access differences by state is substantial and can't be ignored. Following the pilot year study, Maine implemented a new state contract covering the purchasing costs and process requirements for all Maine middle school one-to-one laptop program. There

was a delay in the final implementation of the contract due to disagreements between some school districts and the State of Maine Education Department leadership regarding vendor selection. This delay could have caused a delay in new devices getting into the hands of students. It may have also allowed for schools to purchase other non-laptop digital devices. This could have potentially led students and teachers to answer “no” when responding to laptop access questions on the Internet use surveys.

The increase in the frequency of Internet related tasks in Connecticut appears to mirror the increase in student laptop access. This factor plus the sharp decline in student laptop access differences alone could certainly play a large role in the inability for a replicate of the overall finding of significant differences between the states after conditioning on covariates. The increase of access and use of laptops in Connecticut appear to have nullified the attempt to replicate significant findings in the replicated study which demonstrated the advantage for Maine students, with greater access to laptops in a one-to-one environment, on a measure of online research and learning.

The addition of offline reading measures in the validation study did support higher mean scores for students in Maine and the differences were significant, however, because they were not part of the pilot study it is not possible to draw conclusions of impact level between the two studies.

New Results

Time on task predicated on access to technology appears to play a role regarding student performance on online research and learning tasks. It would follow, both in the literature and the limited evidence from the validation study, that an increase in laptop access or access to a similar

device (that has Internet access) and greater required use of the device may lead to improved learning and better skill in online research.

Significance

The importance of skills and abilities for students in online research for learning in school classrooms will almost certainly increase over time (Christensen, Horn, & Johnson, 2008). One example, North Carolina has recently passed state legislation that requires all public school system curricula (standards, content, resources, and instructional tools) to be in a digital format across the state by 2017 (Session Law, 2013). Another example is that a large number of job openings in the United States in science and science related fields, as well as other knowledge worker jobs in general, are going unfilled currently due to a lack of qualified candidates (Mangan, 2013; Rothwell & Ruiz, 2013). Unfortunately, much of the blame for this unmet demand falls on a U.S. educational system and its inability to prepare students for these jobs. In 2011, only 32% of U.S. eighth graders were at or above Proficient on the NAEP science assessment (National Center for Education Statistics, 2011). Today's students must both learn the traditional skills and knowledge in the scientific domain and the scientific literacy skills necessary for real scientific work (Cervetti et al., 2005). This must all be done within a new, digital environment including, most importantly, the Internet (CCSS, 2010).

This study also sought to improve upon previous work, including the ORCA pilot study, with an innovative, updated, and performance based assessment of online research and learning. Given the generally inadequate level of performance by students with online research and learning skills (Kennedy et al., 2016; Leu et al., 2015), this study attempts to inform professional development work for practicing teachers by identifying possible areas to improve instructional

practices that are related to successful online research and to more completely maximize the value of one-to-one laptop initiatives.

An increasing number of schools in Europe report one-to-one laptop access for students. In Norway, approximately 90% of 11th grade students are in a one-to-one program (N.A., 2013). As evidenced by the policy in Maine, similar changes are taking place, though some slowly and without adequate support or professional development, in the United States (Bebell & O'Dwyer, 2010), Australia (New South Wales Department of Education and Training, 2009; Crook, Sharma, Wilson, 2015), and other nations. One-to-one computing is an expensive investment for schools, states, and nations. There have been many ongoing discussions questioning the wisdom of investing in one-to-one programs given the limited efficacy data to date (Hu, 2007; Zucker & Light, 2009). For a variety of reasons, previous research on one-to-one laptop initiatives has not been able to provide much useful information on the efficacy of this expensive investment. This study attempted to replicate the aforementioned previous study that found modest but significant positive outcomes on a one-to-one initiative. In the pilot study, the adjusted mean scores for online research and learning were generally significantly higher for the state that provided laptops to middle school students. The overall effect size was comparable to about a half a year of annual growth of standardized reading scores at the middle school level, the same amount of time that students had access to one-to-one laptops in their classrooms. This was consistent with the findings in the validation study where Maine students were significantly better at locating information than students in Connecticut.

Students consistently demonstrated an ability to locate information online significantly better than they could any other online learning tasks. This is an important finding in this study to be considered in the larger discussion of technology and its role for learning in general and in

the K-12 classroom specifically. It is quite clear that student access to laptops and teacher assigned Internet activities have increased student proficiency with locate tasks. Unfortunately, the data all shows that emphasis on online learning tasks ends after information has been located. Indeed, this study and the pilot study, demonstrate poor performance overall on all tasks. However, I believe the higher level of performance on the locate tasks and the subsequent drop in other areas supports the argument for more structured online learning tasks in the classroom. Tasks that require sufficient practice and reflection in all areas of online research and learning, not just practice with locating information, should be designed and facilitated by classroom teachers.

New Literacies Theory is a dual-level theory for literacy and learning developed based upon the continuous changes observed in technologies designed for teaching and learning. Since the mainstream adoption of the Internet, the rapidly and continuously changing ecosystem of hardware, software, and digital services is the defining aspect of learning technologies (Ellis & Loveless, 2013). This study, I believe, helps to support in its own small way the building of a substantial body of knowledge that can inform educators and students by embracing the characteristic of change inherent to and so critical for the studying of and learning with these new literacies. Ultimately, this study looked to identify if both greater technology access and improved pedagogy, as measured by time on task, will better prepare students for the new learning and life challenges necessitated by an increasing move to digitize information.

Limitations

Substantial limitations exist in this study; however, steps were taken to limit exposure to these limitations and additional data have been used to address the limitations identified in the

pilot year study in this validation study. Limitations are discussed below that were addressed and should be addressed in future studies.

The main limitation in this study is the degree to which external validity is threatened. Although the findings for both the pilot year study and this study can be generalized to each of the two state populations (participating schools were stratified by SES, geographic location, and offline reading score to be representative of the larger state population) findings cannot necessarily be generalized to other states. To begin to address this threat, participants were described in detail so that a better determination to the extent to which the findings can be compared to other state populations can be made.

Performance assessments present several validity problems that may become difficult to handle with traditional approaches and/or specific criteria for validity research. Performance based assessments often allow students a variety of way to interpret, respond to, and at times design tasks. Because of this, meeting specific validity criteria including reliability, generalizability, and compatibility of assessments can become problematic (Moss, 1992). Extensive efforts were made in the design of the ORCA instrument to include assessment of skills that interact together and build to create a final product but can stand on their own as unique all at the same time acting as a practical measure in the classroom to identity student progress and info instruction.

The pilot study, using year 3 ORCA data, failed to condition on pre-assessment differences between students' ORMs (offline reading measures) between the two states. Offline reading has been demonstrated to be an important predictor of online research and learning (Leu, et al., 2015). Unfortunately, in year 3 results, the two states used unique and separate state assessments of offline that were not comparable. Thus, it was not possible to obtain scores on a

common measure of reading for the students in the two states in the year 3 data set. In the validation study, using year 4 data, students were assessed and data were collected on their offline reading ability and were analyzed as part of this study. In addition, offline reading performance generally tracks with SES level and I did condition on SES (Reardon, 2011, 2013; National Center for Educational Statistics, 2011, 2013). Thus, by conditioning similar correlates and using new ORM data, this study controlled for much of the possible difference in offline reading ability between students in the two states.

The State of Maine's middle school laptop funding program provides schools and school districts with funding for students to receive laptops beginning in the 7th grade. This was the case during the years in which data for the pilot and validation studies were conducted. It is possible that some districts may have issued laptops before 7th grade, however, they would have had to do so by investing local funds. An additional limitation to this study includes the fact that most Maine students only had laptops for approximately six months when they participated in the ORCA. If this is indeed the case, this would lead to fewer opportunities in the classroom for students to engage on online learning tasks versus those students who were issued a laptop for the entire school year.

Additionally, it is possible missing data could have affected the results of this study and the replicated study. There as a considerable number of incomplete student records mainly due to administration issues. To determine if this missing data might affect the analyses, I compared a subset of demographic data and scores from all students and compared them to the students with complete data records. It was determined based on the results that there were no substantial differences.

This validation study compares how often teachers and students report that they use the Internet for school assignments. Specifically, they respond to questions that measure frequency of use and time on task. The pilot study was also limited due to its limited variety and type of question administered to students and teachers in the student and teacher Internet use surveys. Modified and more extensive versions of the two surveys were used in the validation study which provided more data used in research question 4 of this study and more accurate data as many of the question were changed to continuous rather than categorical variables.

In the future, a more comprehensive study should include information that specifically addresses how teachers expect students to use the Internet for assignments and how students are interpreting the assignments and using the Internet. Based on the directions in the surveys and the results of my analysis, it remains unclear if teachers and students shared the same common understanding of Internet days on task and time on task. It could be the case that some students and teachers reported time engaged on tasks but not necessarily time on the specific learning task assigned.

Ultimately, to better inform the larger question this study attempts to answer (do laptops impact student online research and learning and how), we will need better and precise tools working with a far larger sample size. As reported by David Silvernail, co-director of the nonpartisan Maine Education Policy Research Institute, regarding the State of Maine's laptop initiative, "So many other things are going on in schools, it's difficult to classify what makes the difference." (Silvernail et al., 2011).

Implications

As school curricula goes digital, the importance of online information for learning in school classrooms increases accompanied by significant investments in the necessary hardware,

software, services, and professional development. For a variety of reasons, previous research on one-to-one laptop initiatives has not been able to provide much useful information on the efficacy of these current and future expensive investments. This study sought to improve upon previous work with an innovative, updated, performance-based assessment of learning from online information. This research seems to show modest learning gains resulting from the initial Maine one-to-one laptop policy, despite the relatively short time frame during which students had access to laptops before being tested, and from increased use of laptops in Connecticut. Overall, however, the poor performance across all skill areas should be cause for alarm.

Recalling that this study took place in English Language Arts classrooms, it may be that the teachers in this study were faithfully implementing the United States' standards in reading (CCSS, 2010), where not a single anchor standard and not a single grade level band standard for reading in the seventh grade specifically requires the reading of online text (Drew, 2012; Leu et al., 2015). Not a single standard in reading, for example, includes any of the words: "internet," "online," or "digital." This omission in the CCSS is likely to limit instructional time in online research and learning skills for the immediate future, to the detriment of student preparedness for the challenges of the 21st century. As shown in the replicated and current study, better access to digital devices in school (be it laptops, tablets, or cell phones) and a priority on school research tasks that allow for, at a minimum, the use of the Internet must become the norm in U.S. schools.

Learning is profoundly influenced by student prior knowledge (Kintsch, 1998; McNamara & Kintsch, 1996; Voss & Silfies, 1996). It is perhaps possible if not likely that many teachers in both Connecticut and Maine, not always familiar with how learning changes online, only interpret the new CCSS standards with a lens to the past and traditional text versus a lens to the future and Internet based texts and multimedia. Online research requires additional reading

skills (Afflerbach & Cho, 2010; Coiro, 2011; Coiro & Dobler, 2007; Leu, Castek, & Hartman, 2006). As an example, CCSS - Reading Standard, 1, often referred to as “close reading” requires students to read carefully, make inferences, and provide evidence for these inferences.

Textbooks used frequently by teachers for reading instruction (e.g. Cummins, 2015; McLaughlin & Overturf, 2012; Tompkins, Campbell, Green & Smith, 2015) recommend teaching “close reading” strategies for use with traditional narrative text. These textbooks do not include, however, recommendations or guidance regarding Internet based texts. Close reading could be taught, for example, in relation to inferring the best link from a set of search results during an online research task (Kennedy et al., 2016). If current trends hold, information will become more and more digitized over time, accessible by more and varied digital devices. Each of the reading standards in the CCSS, along with other CCSS standards in other academic disciplines, could and should be taught in relation to online research in this ever-increasing digital information landscape.

While not studied in this validation study, given the generally inadequate level of performance by students with online research and the limited Internet use initially reported by teachers in Maine and the even smaller use reported by Connecticut teachers, results may suggest a limited amount of teacher professional development time for knowledge acquisition and practice for the integration of laptops into the classroom research process. Some research suggests that professional development focused on technology integration requires substantially more time than professional development with instructional practices that do not require the use of technology (Jones, 2004; Helsel DeWert & Levine Cory, 1998; McKenzie, 2001). Time required to generate positive student outcomes is greater with technology integration because teachers must typically learn, or at least become proficient in both skill with new technologies

that will be used in the classroom and skill at the new instructional practices that those technologies require (Goldman, Lawless, Pellegrino, & Plants, 2005). Some research suggests that the time line for expert level proficiency (that which can support significant study gains) in the two areas may take three to five years (Jones, 2004; McKenzie, 2001; Saylor and Kehrhahn, 2003). These findings indicate that a district or state that is developing or working to sustain a one-to-one program (or at a minimum supporting digital device use for every student) must provide adequate financial resources and time for professional learning to build teacher capacity for integrating technology into the curricula.

This study supports the growing need for new and innovative professional development to assure teachers develop more insightful and effective strategies for technology integration. To better support the ongoing professional learning needs of both teachers to design technology integrated lessons and for students to improve online research skills, performance based assessments in the form of simulations when and where possible should be utilized. Performance based assessments can provide teachers with evidence of student ability in a variety of contexts. The contexts can be tailored to better identify micro-level skills or macro-level integration of online skill areas. Performance based assessments provide teachers with flexibility and feedback to better design class lessons and to better differentiate based on individual student needs. Simulations based on authentic situations provide assessment opportunities that give students confidence that they are engaging in meaningful tasks and being assessed on practical skills and abilities. Simulations can also provide timely and where appropriate, immediate feedback to situate students in an environment to practice decision making and in the context of online research stimuli to assess and incorporate into their current information space. The time and expertise typically needed to develop valid and reliable performance based assessments, especially simulations, can be substantial. However, with the continued march of OER (open educational resources) shared

online across the Internet, teachers with the skills to find and assess them will have a plethora of options available to them that can be copied and adapted as needed.

Finally, if the pattern of significant SES differences between states and districts persists as discussed, and we see a second digital skills divide not just a hardware divide, we may require more equitable state and national policies with respect to online access and instruction for online research and learning skills.

Future Research

As mentioned, Maine's one-to-one program universally begins at the seventh-grade level, though exceptions exist based on local district priorities. Thus, most students from Maine received their first laptop in grade seven and, since testing took place after January, had been using it in the classroom for only about half of a school year. The results presented in this study should be interpreted considering this limited amount of time that Maine students had been using laptops in their classrooms. The impact of laptop use may well be cumulative, continuing each year through the grades, as students continue to benefit from the use of one-to-one laptops in the classroom. If so, the true long-term impacts of the one-to-one laptop policy are much greater than the impacts reported here. This additional research would be important to conduct.

It is also important to note and acknowledge recent work on paired research tasks in relation to models of one-to-one computer access. This initial work suggests that collaborative online research tasks, completed in pairs, may lead to greater student learning for both students as compared to individual student online research tasks (Kiili, Laurinen, Marttunen, & Leu, 2012; Passig & Maidel-Kravetsky, 2014). Findings demonstrate that pairs of students, reading online information in a learning task, perform two tasks beyond the typical tasks complete alone. First, pairs may be more likely to support the comprehension monitoring of a partner which supports

immediate learning in the specific activity. Second, pairs can teach one another important new online learning skills, based on their current unique abilities and strengths, to support individual learning over extended periods of time. If instructional practices take advantage of these collaborative opportunities that appear to exist during online research, the potential financial costs of one-to-one initiatives may be reduced and the benefits of shared use maximized. Please note, this line of work has been largely qualitative in nature. It suggests however, that additional quantitative work, in a wider variety of online learning contexts with a wider and more varied sample, may be appropriate and beneficial.

We have recently seen a new phenomenon appear in U.S. classrooms, namely the greater of presence of and approved access of student Internet-connected cell phones by students. Traditionally, cell phone use in the classroom was not allowed and seen as distraction not as a tool for student learning (Burns & Lohenry, 2010). A Pew Research (Purcell, Heaps, Buchanan, & Friedrich, 2013) report recently found that teachers reported in both in surveys and focus groups that cell phones are becoming an integral part of the learning experience for students. Asked whether their AP (advanced placement) students used cell phones for any specific learning-related tasks, teachers reported students using a cell phone “to look up information in class,” in 42% of their classes. This was followed closely by students using cell phones to “take pictures or record video to use in class assignments” in 38% of their classes.

However, the impact of cell phones in the classroom appears to impact students less in rural areas than those teaching in urban or suburban schools. In the same Pew Research (Purcell, Heaps, Buchanan, & Friedrich, 2013) report, only 28% of teachers in rural schools report students using phones to look up information in class, and fully 64% say students are not permitted to have cell phones in class. This is in stark contrast with 47% of surveyed teachers in

urban schools and 46% in suburban school who say their students use cell phones to look up information in class, and just 46% in urban school and 45% in suburban school who say students cannot have cell phones in class. To put these findings in context, as of 2010, Connecticut was approximately 62% rural and 38% urban whereas Maine was approximately 99% rural and 1% urban (U.S. Census Bureau, 2010). It would then follow that students in a far more rural state, Maine, would have a much higher chance of having cell phones not permitted in class and far fewer opportunities to use a cell phone to look up information in class. As mentioned previously, findings across both studies show a relationship between student performance on our measure of online research and learning and access to and frequency of interest related tasks.

Immediately following the United States presidential election in November, many popular news outlets attributed much of Donald Trump's success to his supporters' use of social media (Khan, 2016; Lapowsky, 2016; Read, 2016). A national U.S. survey of 1,520 adults conducted March 7-April 4, 2016, found that Facebook was the most popular U.S. social networking platform with 79% of *online* Americans using Facebook (Greenwood, Perrin & Duggan, 2016). The number of online adults who report using Facebook has increased by 7 percentage points compared with a Pew Research Center survey conducted at a similar point in 2015, 76% of which reported that they visit Facebook on a daily basis (Greenwood, Perrin & Duggan, 2016). These numbers do not include the additional social networking activity of users at other popular sites including Instagram (32% of U.S. adults), Twitter (24% of U.S. adults), and LinkedIn (29% of U.S. adults). Data collected on teens' (ages 13 to 17) use of social media demonstrates similar usage patterns in both the size and growth of social networking participation. Facebook remains the most popular social media site among U.S. teens with 71% usage (Lenhart, 2015). This is in addition to 50% of teens using Instagram and 40% using Snapchat. With this current and

growing level of demonstrated engagement in the use of social media, for both adults and teens alike, a full picture of how students perform online research appears incomplete. Without additional investigation into teen usage of social media to learn specifically how they are using social networking tools to locate, evaluate, synthesize, and communicate information, I fear we will fall short of satisfactorily understanding the teen information space and certainly be at a disadvantage to help support teachers in their efforts to leverage social networking tools for learning.

Finally, online research and learning appears to play an even more important role in a newly developing and promising framework called personal digital inquiry (Coiro, Castek, & Quinn, 2016) or PDI. This new way of thinking about middle school education integrates practices that represent both classic and contemporary principles of inquiry-based learning (Bruce & Bishop, 2008) and constructivism (Jonassen, 1991), plus elements of cognitive apprenticeship (Collins, Brown & Holum, 1991) and ideas associated with connected learning (Ito, Gutiérrez, Livingstone, Penuel, Rhodes, Salen & Watkins, 2013). Connected learning: An agenda for research and design. Digital Media and Learning Research Hub.) and design thinking (Martin, 2009). At the core of the framework is student inquiry. Inquiry that values the use of technology to assist students to acquire (e.g. locate, evaluate, synthesize) information through technologies such as on-demand videos, virtual presentations, and informational websites as a first step toward active knowledge building (Coiro, Castek & Quinn, 2016). Pairing these technologies with student online research skills and abilities through an inquiry process can enhance content knowledge, literacy learning, and social learning and collaboration (Pelekis & Phillips, 2014). Now, more so than any time in history because of the Internet, students are empowered to engage in personal inquiry around local or global problems and issues (Hobbs & Moore, 2013).

Next Steps

Ultimately, greater technology access, more and measured time on task, and improved pedagogy will be required to prepare students to take on the ill-defined, global challenges that are most threatening our society and our world. These challenges, which are ultimately learning challenges, can only be addressed through the affordances provided by increased access to Internet based information. The sooner our students become proficient with online research and learning skills and abilities to harness this online information, as discussed in this study, the sooner they will become a productive part of the solutions.

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APPENDICES

Appendix A - Student Internet Use Survey (SIUS)

(Original Administered with Survey Monkey Interactive Formatting)

Your responses will be kept confidential:

1. Name:
2. School:
3. Teacher:
4. Date:

PART I. Tell us about the computers you have at home.

5. How many computers, laptops, iPads, netbooks, or tablets are in your home and connected to the Internet?
6. Do you have a smartphone that you use to view webpages at home? a. Yes 2. No
7. Which type of device do you use most often to view webpages and do research at home? a. Computer, Laptop, iPad, Netbook, or Tablet
b. Smartphone
c. Other
8. If you have Internet at home, can you view online videos? a. Yes 2. No

PART II. Please tell us WHERE AND HOW you use the Internet.

9. Do you have your own laptop that you use at school and home? a. Yes 2.No
10. Where do you use the Internet most often?
 - a. I don't use the Internet
 - b. School
 - c. Home

- d. Public library
- e. Relative's house
- f. Friend's house
- g. Other

11. For your English Language Arts class, about how many days per month (out of 28 days) do you work on assignments where your teacher **REQUIRES** you to use the Internet?
12. For your English Language Arts class, about how many days per month (out of 28 days) do you work on assignments where you **CHOOSE** to use the Internet, even though it is not required?
13. About how many school days per month (out of 20 days) do you have a lesson with a teacher, librarian, or library/media specialist on how to use the Internet?
14. How often do you check the accuracy of information when you use the Internet?
 - a. Never
 - b. Almost never
 - c. Sometimes
 - d. Frequently
 - e. Every time I use the Internet
15. How often do you check the reliability of information when you use the Internet?

- a. Never
- b. Almost never
- c. Sometimes
- d. Frequently
- e. Every time I use the Internet

16. On average, how many hours do you spend on the Internet each day, both in school and out of school?

PART III. Using the Internet at School.

17. How often are you able to individually use of a computer/laptop/ipad/netbook/etc. during English Language Arts class?

- a. NEVER. I NEVER have individual use of a computer/laptop/ipad/netbook/etc during my class.
- b. RARELY. I RARELY (once a month or less) have individual use of a computer/laptop/ipad/netbook/etc during my class.
- c. SOMETIMES. I SOMETIMES (a few times a month) have individual use of a computer/laptop/ipad/netbook/etc during my class.
- d. OFTEN. I OFTEN (a few times a week) have individual use of a computer/laptop/ipad/netbook/etc during my class.
- e. ALWAYS. I ALWAYS have individual use of a computer/laptop/ipad/netbook/etc during my

class. We have a one-to-one program in our school.

18. On average, about how much time EACH DAY do you use the Internet at school?

Please select the appropriate number of school days each month (out of 20 days) that you use the Internet in these ways AT SCHOOL.

19. AT SCHOOL, I use a social network like Facebook ...

20. AT SCHOOL, I use the Internet to do research and write reports ...

21. AT SCHOOL, I text, chat, or instant message ...

35

22. AT SCHOOL, I read or write email ...

23. AT SCHOOL, I read or write wikis ...

24. AT SCHOOL, I read or write blogs ...

25. AT SCHOOL, I use apps ...

26. AT SCHOOL, I use the Internet to find out about movies, music, sports, hobbies, or other items of personal interest ...

27. AT SCHOOL, I use the Internet for my science class ...

28. AT SCHOOL, I use the Internet for my social studies class ...

29. AT SCHOOL, I use the Internet for my English/language arts class ...

30. AT SCHOOL, I use the Internet for my math class ...

PART IV. How should the Internet be used at school to increase learning?

31. You are exploring the Internet. You find an interesting website that says students are really the experts when it comes to Internet use. It asks students to share their best ideas about how the Internet should be used at school to increase learning in subjects such as science, mathematics, social studies, language arts, and others. You decide to share your own ideas. How should the Internet be used at school to increase learning in subjects such as science, mathematics, social studies, language arts, and others.

PART V. Using the Internet Outside of School

32. On average, about how much time EACH DAY do you use the Internet outside of school?

Now, please select the appropriate number of days each month (out of 28 days) that you use the Internet in these ways OUTSIDE OF SCHOOL.

- 33. OUTSIDE OF SCHOOL, I use a social network like Facebook ...
- 34. OUTSIDE OF SCHOOL, I use the Internet to do research and write reports ...
- 35. OUTSIDE OF SCHOOL, I text, chat, or instant message ...
- 36. OUTSIDE OF SCHOOL, I read or write email ...
- 37. OUTSIDE OF SCHOOL, I read or write wikis ...
- 38. OUTSIDE OF SCHOOL, I read or write blogs ...
- 39. OUTSIDE OF SCHOOL, I use apps ...
- 40. OUTSIDE OF SCHOOL, I use the Internet to find out about movies, music, sports, hobbies, or other items of personal interest ...
- 41. OUTSIDE OF SCHOOL, I use the Internet for my science class ...

- 42. OUTSIDE OF SCHOOL, I use the Internet for my social studies class ...
- 43. OUTSIDE OF SCHOOL, I use the Internet for my English/language arts class ...
- 44. OUTSIDE OF SCHOOL, I use the Internet for my math class ...

PART VI. How Well Can You Use The Internet.

Please check the box that best describes your skill level for each item. 45. I can use a social network like Facebook.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

46. I can use the Internet to do research and write a short report.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

47. I can locate any information I need on the Internet.

- a. I DON'T KNOW how to do this.

- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

48. I can summarize information together from several different websites.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

49. I can use email to share important information with people.

36

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

50. I can use a wiki to share important information with people.

- a. I DON'T KNOW how to do this.

- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

51. I can find out who the author is of a website.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

52. I can determine if a website's author is an expert or not.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

53. I can determine the point of view of a website's author.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.

- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

54. I can evaluate the reliability of information at a website.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

Motivations for Reading Online Measure

Directions: We are interested in your research and reading on the Internet. These sentences tell how students feel about research and reading on the Internet. Read each sentence and decide whether it talks about a person who is like you or different from you. For all of the sentences, you should think about the kinds of things you do when you research and read on the Internet.

55. Here is one question to try for practice: I like to do research and read on the Internet about music. If the statement is very different from you, select 1.

If the statement is a little different from you, select 2.

If the statement is a little like you, select 3.

If the statement is a lot like you, select 4.

- a. Very different from me.
- b. A little different from me.
- c. A little like me.

d. A lot like me.

Okay, we are ready to start. You should think about the things you research and read on the Internet.

56. I learn a. b. c. d.

57. On the a.

b. c. d.

a lot when I do research and read on the Internet. V ery different from me.

A little different from me.

A little like me.

A lot like me.

Internet, I do research and read about my favorite topics as often as I can.

V ery different from me. A little different from me. A little like me.

A lot like me.

58. I can become better at doing research and reading on the Internet by putting effort into my work. a. Very different from me.

37

b. A little different from me.

c. A little like me.

d. A lot like me.

59. I do not believe that doing research and reading on the Internet is useful in everyday life.

a. V ery different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

60. I enjoy doing research and reading about new things on the Internet.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

61. I find it fun to do research and read on the Internet.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

62. I believe that doing research and reading on the Internet is more useful than any of my other school activities.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

63. On the Internet, understanding the material I find is extremely important to me.

a. V ery different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

64. I don't believe that working hard helps me get better at doing research on the Internet.

a. V ery different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

65. What I learn on the Internet is valuable to me.

a. b. c. d.

66. I have a. b. c. d.

V ery different from me. A little different from me. A little like me.

A lot like me.

favorite subjects that I like to do research and read about on the Internet. V ery different from me.

A little different from me.

A little like me.

A lot like me.

67. I believe that working hard when I do research and read on the Internet will help me get better.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

68. I am outstanding at doing research and reading on the Internet.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

69. I can figure out unfamiliar words on the Internet.

a. Very different from me.

38

b. A little different from me.

c. A little like me.

d. A lot like me.

70. I could not care less about the topics on the Internet.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

71. For me, doing research and reading on the Internet is time well spent.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

72. I believe that practice will help me with doing research and reading on the Internet.

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

73. I cannot find the main idea of an article on the Internet.

- a. Very different from me.
- b. A little different from me.
- c. A little like me.
- d. A lot like me.

74. I believe that working hard helps me improve in doing research and reading on the Internet.

- a. Very different from me.
- b. A little different from me.
- c. A little like me.
- d. A lot like me.

75. I believe that I can learn how to do research and reading on the Internet.

- a. Very different from me.
- b. A little different from me.
- c. A little like me.
- d. A lot like me.

76. If a topic is interesting to me, I always try to do research and read about it on the Internet.

a. b. c. d.

77. I will do a.

b. c. d.

Very different from me.

A little different from me.

A little like me.

A lot like me.

well the next time I do research and read on the Internet. Very different from me.

A little different from me.

A little like me.

A lot like me.

78. When

a. Very different from me.

b. A little different from me.

c. A little like me.

d. A lot like me.

79. It is very important to me to be good at doing research and reading on the Internet. a.
Very different from me.

b. A little different from me. c. A little like me.

d. A lot like me.

Appendix B - Teacher Internet Use Survey (TIUS).

(Original Administered with Survey Monkey Interactive Formatting)

Your responses will be kept confidential:

1. Name:
2. School:
3. Date:

PART I. Tell us about your background and your classroom situation.

4. How many years have you taught?
5. What is your highest academic degree obtained?
 - a. B.A./B.S. b. Masters
 - c. Masters plus additional courses d. Ed.D/Ph.D
6. How many years have you used the Internet for personal use?
7. How many years have you integrated the Internet into classroom instruction?
8. Which of the following best describes your students' individual access to a computer/laptop/ipad/netbook/etc. during your English Language Arts class?
 - a. NEVER. My students NEVER have individual access during my class.
 - b. RARELY. My students RARELY (once a month or less) have individual access during my class.
 - c. SOMETIMES. My students SOMETIMES (a few times a month) have individual access during my class.

- d. OFTEN. My students OFTEN (a few times a week) have individual access during my class.
- e. ALWAYS. My students ALWAYS have individual access during my class. We have a one-to-one

program in our school.

how many hours of professional development on technology integration have you received during

9. About
the past four years FROM YOUR SCHOOL DISTRICT?

- 10. About how many hours of professional development on technology integration have you received during the past four years ON YOUR OWN INITIATIVE?
- 11. How much does your state testing program influence what you teach in English Language Arts?
 - a. It NEVER influences what I teach.
 - b. It RARELY influences what I teach.
 - c. It SOMETIMES influences what I teach.
 - d. It OFTEN influences what I teach.
 - e. It ALWAYS influences what I teach.
- 12. To what extent do you agree with the following statement: "I am more likely to teach Internet research skills if they appear on the state assessments."
 - a. I do not agree.

b. I somewhat agree.

c. I largely agree.

d. I completely agree.

PART II. Tell us about how you use the Internet in the classroom.

13. Are your students permitted to use email in class? a. Yes b. No

14. Are your students permitted to access a wiki or blog in class? a. Yes b. No

15. Are your students permitted to engage in collaborative online activities with another classroom outside of your district?

a. Yes b.No

30

16. About how many days per month (out of 28 days) do you REQUIRE students to use the Internet for a school assignment?

17. About how many days per month (out of 28 days) would you estimate that students CHOOSE to use Internet for a school assignment?

18. On average, about how much time each day do you spend on the Internet at home and at school?

19. On average, about how much time EACH DAY do students use the Internet in each of your classes? Please select the appropriate number of class days each month (out of 20 days) that you have your class use the Internet in these ways AT SCHOOL.

20. I have my class use a social network like Facebook ...

21. I have my class use the Internet to do research and write reports ...
22. I have my class text, chat, or instant message ...
23. I have my class read or write email ...
24. I have my class read or write wikis ...
25. I have my class read or write blogs ...
26. I have my class use apps ...
27. I have my class use the Internet to find out about movies, music, sports, hobbies,
or other items of personal
interest ...
28. I have my class use the Internet for my English/language arts class ...
29. I have my class use word processing software ...
30. I have my class use presentation software (e.g. Powerpoint) ...
31. I have my class use graphic/video/audio software (e.g. PhotoShop, iMovie) ...
32. I have my class use webpage creation tools ...
33. I have my class use virtual simulations ...
34. I have my class use virtual worlds ...

PART III. How well do you use the Internet?

Please check the box that best describes your skill level for each item.

35. I can use a social network like Facebook.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

36. I can use the Internet to do research and write a short report.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

37. I can locate any information I need on the Internet.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

38. I can summarize information together from several different websites.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

39. I can use email to share important information with people.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

40. I can use a wiki to share important information with people.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

41. I can find out who the author is of a website.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

42. I can determine if a website's author is an expert or not.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

43. I can determine the point of view of a website's author.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

44. I can evaluate the reliability of information at a website.

- a. I DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.
- c. My skills are AVERAGE in this area.
- d. My skills are EXCELLENT in this area.

PART IV. How should the Internet be used at school to increase learning?

45. You are exploring the Internet. You find an interesting website that says teachers are the experts in the classroom use of the Internet. It asks teachers to share their best ideas about how the Internet should be used at school to increase learning in subjects such as science, mathematics, social studies, language arts, and others. You decide to share your own ideas. How should the Internet be used at school to increase learning in subjects such as science, mathematics, social studies, language arts, and others.

PART V. How well can your students use the Internet?

Please check the box that best describes your students' skill level for each item

46. My students can use a social network like Facebook.

- a. My students DON'T KNOW how to do this.
- b. My students' skills are LIMITED in this area.
- c. My students' skills are AVERAGE in this area.
- d. My students' skills are EXCELLENT in this area.

47. My students can use the Internet to do research and write a short report.

- a. My students DON'T KNOW how to do this.

- b. My students' skills are LIMITED in this area.
- c. My students' skills are AVERAGE in this area.
- d. My students' skills are EXCELLENT in this area.

48. My students can locate any information they need on the Internet.

- a. My students DON'T KNOW how to do this.
- b. My students' skills are LIMITED in this area.
- c. My students' skills are AVERAGE in this area.
- d. My students' skills are EXCELLENT in this area.

49. My students can summarize information together from several different websites.

- a. My students DON'T KNOW how to do this.
- b. My students' skills are LIMITED in this area.
- c. My students' skills are AVERAGE in this area.
- d. My students' skills are EXCELLENT in this area.

50. My students can use email to share important information with people.

- a. My students DON'T KNOW how to do this.
- b. My skills are LIMITED in this area.

c. My skills are AVERAGE in this area.

d. My skills are EXCELLENT in this area.

51. My students can use a wiki to share important information with people.

a. My students DON'T KNOW how to do this.

b. My students' skills are LIMITED in this area.

32

c. My students' skills are AVERAGE in this area.

d. My students' skills are EXCELLENT in this area. 52. My students can find out who the author is of a website.

a. My students DON'T KNOW how to do this.

b. My skills are LIMITED in this area.

c. My skills are AVERAGE in this area.

d. My skills are EXCELLENT in this area.

53. My students can determine if a website's author is an expert or not.

a. My students DON'T KNOW how to do this.

b. My students' skills are LIMITED in this area.

c. My students' skills are AVERAGE in this area.

- d. My students' skills are EXCELLENT in this area.

54. My students can determine the point of view of a website's author.

- a. My students DON'T KNOW how to do this.
- b. My students' skills are LIMITED in this area.
- c. My students' skills are AVERAGE in this area.
- d. My students' skills are EXCELLENT in this area.

55. My students can evaluate the reliability of information at a website.

- a. My students DON'T KNOW how to do this.
- b. My students' skills are LIMITED in this area.
- c. My students' skills are AVERAGE in this area.
- d. My students' skills are EXCELLENT in this area.

PART VI. Potential Barriers to Internet integration in the classroom.

To what extent does each of these items limit the effective integration of the Internet in your class for

teaching and learning?

56. Computer/iPad/etc. access for students in my classroom.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.

- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

57. Professional development on Internet integration in the classroom.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

58. The network infrastructure at my school (e.g. speed, reliability).

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.

- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

59. The blocking of websites by my IT department.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

60. School leadership in technology integration by my principal.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

61. School leadership in technology integration by the central office.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

62. The amount of time it takes to learn new aspects of the Internet.

33

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

63. Access to email for my students.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.

- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

64. Access to wikis for my students.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

65. Access to blogs for my students.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

66. Wifi in our school.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

67. High quality instructional materials on the Internet.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

68. Knowing effective instructional models for the Internet.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.

- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

69. Practical assessments of students' ability to conduct research on the Internet.

- a. This DOES NOT LIMIT my ability to effectively integrate the Internet in my classroom.
- b. This SOMEWHAT LIMITS my ability to effectively integrate the Internet in my classroom.
- c. This LIMITS my ability to effectively integrate the Internet in my classroom.
- d. This SIGNIFICANTLY LIMITS my ability to effectively integrate the Internet in my classroom.

Appendix C - Offline Reading Measure (ORM)

Offline Reading Measure

PASSAGE I: *Blue Crabs*

PASSAGE II: *Sharebots*

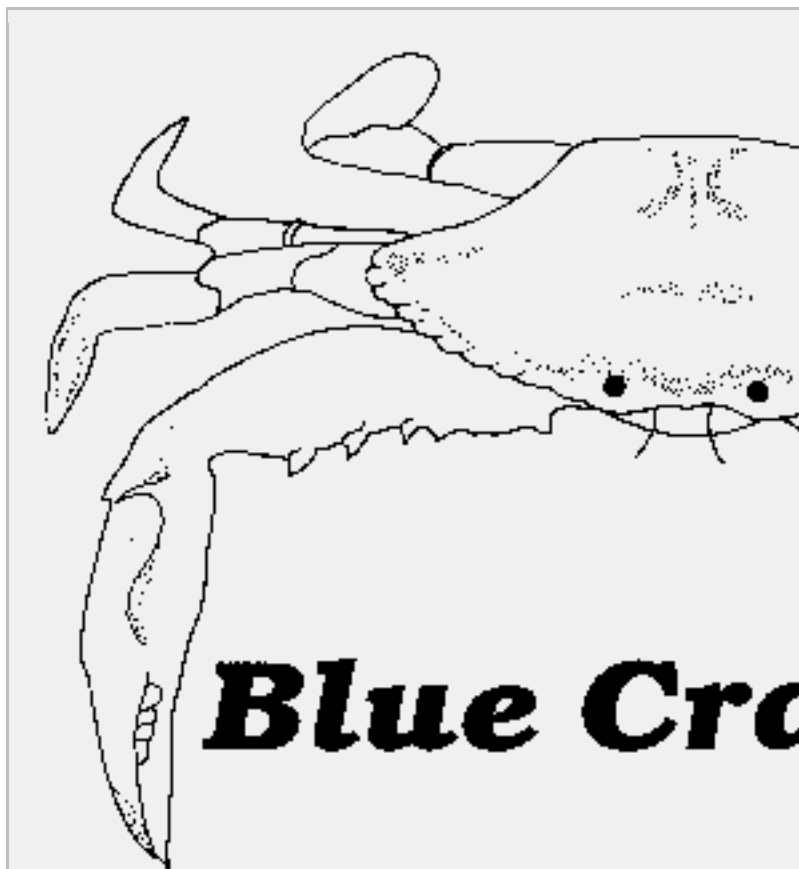
First and last name _____

School _____

Date _____

Directions: Read each passage. Then answer the questions beneath each passage.

PASSAGE I



By George W. Frame

Blue crabs are very strong. Their big claws can make a painful pinch. When cornered, the crabs boldly defend themselves. They wave their outstretched claws and are fast and ready to fight. Keith and I had to be very careful to avoid having our fingers pinched.

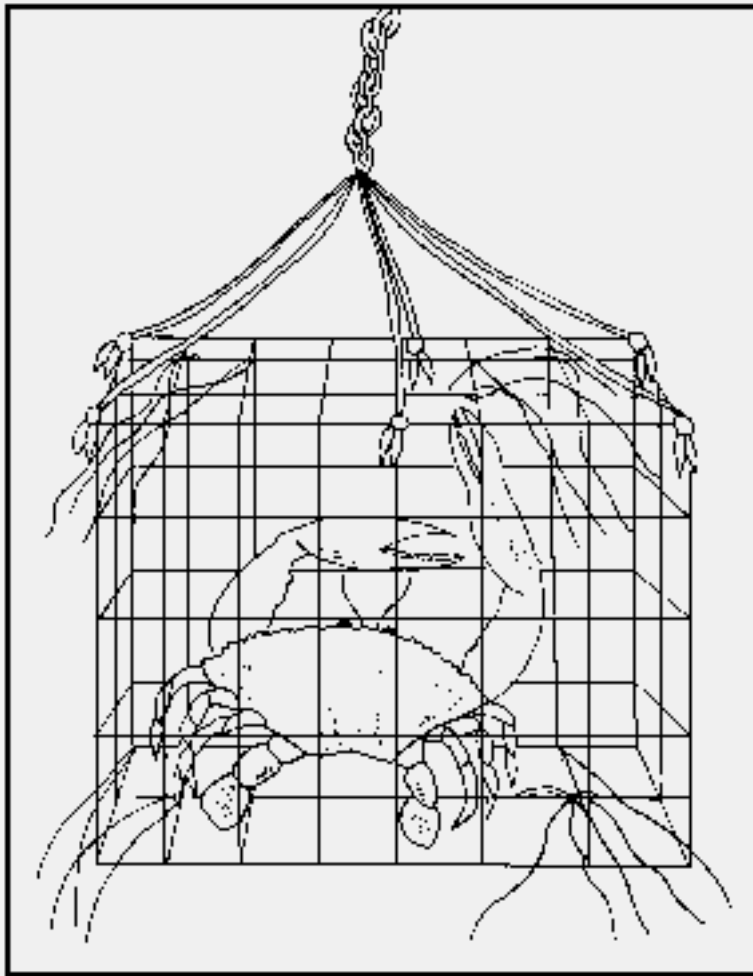
Crabs are **arthropods**, a very large group of animals that have an external skeleton and jointed legs. Other kinds of arthropods are insects, spiders, and centipedes. Blue crabs belong to a particular arthropod group called **crustaceans**. Crustaceans are

abundant in the ocean, just as insects are on land.

The blue crab's hard shell is a strong armor. But the armor must be cast off from time to time so the crab can grow bigger. Getting rid of its shell is called **molting**.

Each blue crab molts about twenty times during its life. Just before molting, a new soft shell forms under the hard outer shell. Then the outer shell splits apart, and the crab backs out. This leaves the crab with a soft, wrinkled, outer covering. The body increases in size by absorbing water, stretching the soft shell to a much larger size. The crab hides for a few hours until its new shell has hardened. Keith and I sometimes found these soft-shell crabs clinging to pilings and hiding beneath seaweed.

Blue crabs mate when the female undergoes her last molt and still has a soft shell. The male courts her by dancing from side to side while holding his claws



outstretched. He then transfers sperm to the female, where they are stored until egg laying begins several months later. The female blue crab mates only once but receives enough sperm to fertilize all the eggs that she will lay in her lifetime. Usually she lays eggs two or three times during the summer, and then she dies.

When the eggs are fertilized and laid, they become glued to long hairs on the underside of the female's abdomen. The egg mass sometimes looks like an orange-brown sponge and contains up to two million eggs until they hatch — about nine to fourteen days later. Only one of the blue crabs that we caught last summer was carrying eggs, and we returned her to the water so her eggs could hatch. Most females with eggs stay in the deeper, saltier water at the ocean's edge rather than in the marshes.

The young blue crabs, and most other young crustaceans, hatch into larvae that look very different from their parents. The tiny blue crab babies are hardly bigger than a speck of dust. They are transparent and look like they are all head and tail. These larvae swim near the surface of the sea, and grow a new and bigger shell every few days. They soon change in shape so that they can either swim or crawl around on the bottom. Then they molt again and look like tiny adult crabs. After that their appearance does not change, but they continue to molt every twenty or thirty days as they grow.

As blue crabs become older, some move into shallower waters. The males in particular go into creeks and marshes, sometimes all the way to the freshwater streams and rivers. Keith and I caught ninety-two blue crabs in the shallow creek of the tide marsh last summer. Eighty-seven of those crabs were males, and only five were females.

Gulls find and eat many blue crabs. They easily catch crabs that hide in puddles at low tide. Other predators are raccoons, alligators, and people. If caught, the crabs sometimes drop off a leg or claw to escape. Seven of the blue crabs that Keith and I caught were missing a claw.

Crabs are able to replace their lost limbs. If a leg or claw is seriously injured, the crab drops it off. The opening that is left near the body closes to prevent the loss of blood. Soon a new limb begins growing at the break. The next time the crab molts, the tiny limb's covering is cast off, too, and the crab then has a new usable leg or claw. The new limb is smaller than the lost one. But by the time the crab molts two or three more times, the new leg or claw will be normal size.

Many fishermen catch crabs to sell. Most are caught in wire traps or with baited lines during the summer while the crabs are active. In the winter, the fishermen drag big nets through the mud for the dormant crabs. Commercial fishermen catch a lot of crabs, sometimes more than 50 million pounds in a year. And many other crabs are caught by weekend fishermen who

crab for fun and food.

The blue crab has a scientific name, just like all other living things. Its name is *Callinectes sapidus*. In the Latin language *Callinectes* means "beautiful swimmer," and *sapidus* means "delicious." I think that scientists gave the blue crab a very appropriate name.

WO000016

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For questions 1-3, choose the answer you think is best. Circle the letter of your answer.

1. 1. According to the passage, what do blue crabs have in common with all other arthropods?
 1. A. They have a skeleton on the outside of their bodies.
 2. B. They hatch out of a shell-like pod.
 3. C. They live in the shallow waters of North America.
 4. D. They are delicious to eat.
1. 2. The growth of a blue crab larva into a full-grown blue crab is most like the development of
 1. A. a human baby into a teen-ager
 2. B. an egg into a chicken
 3. C. a tadpole into a frog
 4. D. a seed into a tree
1. 3. Just after molting, how does a blue crab increase in size?
 1. A. Its body absorbs water.

- 2. B. It drops off its legs and grows new ones.
- 3. C. Its shell grows the way human bones do.
- 4. D. It eats large quantities of food.

1. 4. Describe the appearance of a female blue crab that is carrying eggs.

1. 5. Why does a blue crab hide after molting?

1. 6. The author of the article helps you to learn about blue crabs by
- 1. A. explaining why they are an endangered species
 - 2. B. comparing them to other arthropods
 - 3. C. discussing their place in the food chain
 - 4. D. providing details about their unique characteristics

PASSAGE II

The Sharebots

by CARL ZIMMER

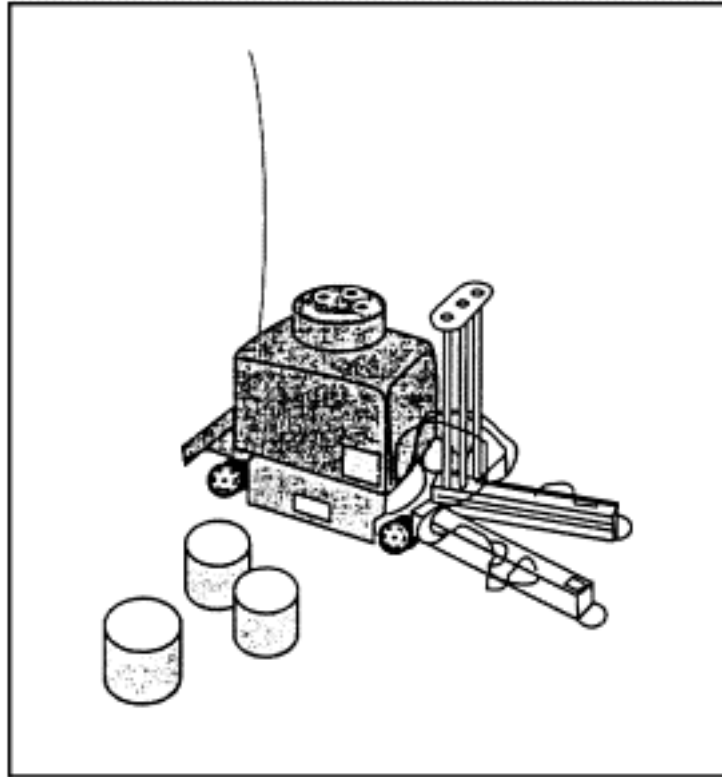
**When robots go to kindergarten in Maja Matarić's lab,
they learn an important lesson about
how to get along in robot society.**

NO MAN IS AN ISLAND, and Maja Matarić thinks no robot should be either. Matarić, a Brandeis University computer scientist, believes robots will do their best work only when they begin to work together. "How do you get a herd of robots to do something without killing each other?" she asks. According to Matarić, you have to put them in societies and let them learn from one another, just as seagulls and baboons and people do. Matarić has already made an impressive start at teaching robots social skills. She has gotten 14 robots to cooperate at once—the biggest gaggle of machines ever to socialize.

The Nerd Herd, as Matarić calls them, are shoe-box-size machines, each of which has four wheels, two tongs to grab things, and a two-way radio. The radio allows them to triangulate their position with respect to two fixed transmitters as they wander around Matarić's lab. It also allows them to broadcast their coordinates and other information to their neighbors. Infrared sensors help the robots find things and avoid obstacles; contact-sensitive strips tell them when they've crashed anyway.

Each robot is programmed with a handful of what Matarić calls behaviors—sets of instructions that enable the robot to accomplish a small goal, like following the robot in front of it. Set one robot on the floor with its wheels turned permanently to the left and program the others to follow, and they will all drive in a circle until their batteries go dead. But Matarić can get more interesting actions out of the herd by programming them to alternate among several behaviors. By telling them to home in on a target, to aggregate when they're too far from one another, to disperse when they're too crowded and to avoid collisions at all times, she's been able to get scattered robots to come together and migrate across her lab like a flock of birds.

More important, the robots can also learn on their own to carry out more complex tasks. One task Matarić set for them was to forage for little metal pucks and bring them home to their nest in a corner of the lab. To give the task a natural flavor, Matarić gave the robots clocks; at "night" they had to go home and rest, and in the "morning" they looked for pucks again. In addition to five basic behaviors they could choose from, she endowed them with a sort of prime directive: to maximize their individual point scores. Each time a robot did something right, such as locating a puck, it was automatically rewarded with points; each time it committed a blooper, such as dropping a puck, it lost points.



Matarić's Nerd Herd, with the pucks they now pursue collectively.

After some random experimentation, the robots soon learned how to forage but not very well, because they tended to interfere with one another in their selfish pursuit of points. "Why should you ever stop and let someone else go?" asks Matarić. "It's always in your interest to go but if everybody feels that way, then nobody gets through and they jam up and fight for space." To make her creatures more efficient, though, Matarić found she didn't have to program them with a God's-eye view of what was good for all robots. She just had to teach each robot to share to let other robots know when it had found a puck, and to listen to other robots in return. "I put in the impetus to pay attention to what other robots are doing, and to try what other robots are trying, sharing the experience," Matarić explains. "If I do some thing that's good and if I say, 'That was really great,' then you may try it."

With this simple social contract, the robots needed only 15 minutes of practice to become altruistic. They would magnanimously announce their discovery of pucks, despite having no way of knowing that this was good for the herd as a whole. At times when two robots lunged for a puck, they would stop and go through an "After you!" "No, after you!" routine, but eventually they figured out the proper way to yield. With social graces, the robot herd brought home the pucks twice as fast as without.

Matarić thinks she'll be able to produce more complex robot societies. "I'm looking at getting specialization in the society so they can say, 'I'll do this, and you do that.' If one of them has a low battery, it may become the messenger that doesn't actually carry

things. And I imagine one robot might emerge as a leader because it happens to be the most efficient. But if it stops being efficient, some other robot will take over."

Carl Zimmer © 1995 The Walt Disney Co. Reprinted with permission of Discover Magazine.

1. 1. Circle the answer choice you think is best. The main purpose of the article is to describe how robots can be programmed to

1. A. locate metal pucks
2. B. work with each other
3. C. recharge their own batteries
4. D. perform five basic behaviors

1. 2. Do you think "The Sharebots" is a good title for the article? Explain why or why not, using information from the article.

1. 3. Based on how the robots in the article are equipped and the behaviors they are programmed to perform, which of the following jobs could they most likely do in someone's home?

1. A. Open cans of food
2. B. Open doors and cabinets
3. C. Pick up shoes on the floor
4. D. Move furniture around a room

1. 4. Maja Matarić describes her group of robots as a "herd." Based on what you know about the behavior of animals in herds, do you think this is a good description? Explain your answer by using examples from the article and what you know about herds.

1. 5. The following sentence appears in the next-to-last paragraph of the article:

"With this simple social contract, the robots needed only 15 minutes of practice to become altruistic."

Based on how the word is used in the article, which of the following best describes what it means to be "altruistic"?

- A. A. To engage in an experiment
 - B. B. To provide assistance to others
 - C. C. To work without taking frequent breaks
 - D. D. To compete with others for the highest score
1. 6. What change occurred when the robots were taught to share?
- 1. A. They did their jobs more efficiently.
 - 2. B. They could accomplish small goals.
 - 3. C. They performed more specialized tasks.
 - 4. D. They began following each other in a line.

1. 7. Do you think it is a good idea for Matarić to "produce more complex robot societies"? Support your opinion with information from the article.

Appendix D. The Scoring Guide for the Offline Reading Measures

SCORING GUIDE FOR OFFLINE READING ASSESSMENTS

Summary of Score points for Offline Reading Assessments

Sharebots Gr. 8	Blue Crabs Gr. 4
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Item 1. MC (B)	Item 1. MC (A)
Item 2. 3 pt OCR (full, partial, little/no comprehension)	Item 2. MC (C)
Item 3. MC (C)	Item 3. MC (A)
Item 4. 3 pt OCR (full, partial, little/no comprehension)	Item 4. 2 pt OCR (acceptable/unacceptable)
Item 5. MC (B)	Item 5. 2 pt OCR (acceptable/unacceptable)
Item 6. MC (A)	Item 6. MC (D)
Item 7. 2 pt OCR (acceptable/unacceptable)	N/A
N/A	N/A
TOTAL: 14 pts 4 MC X 1pt each 2 2pt OCR 1 3pt OCR	TOTAL: 10 pts 4 MC X 1pt each 3 2pt OCR

Multiple Choice [MC] = 0 (incorrect) or 1 (correct)

2 pt Open Constructed Response [OCR] = 0 (incorrect) or 1 (correct)

3 pt OCR = 0 (No comprehension) 1 (Partial comprehension) 2 (Full comprehension)

SOURCE OF ITEMS: <http://nces.ed.gov/nationsreportcard/itmlsx/detail.aspx?subject=reading>

SEE NEXT PAGE FOR SPECIFIC DETAILS ABOUT EACH OPEN-CONSTRUCTED RESPONSE ACROSS BOTH STORIES

Sharebots Gr. 8	Blue Crabs Gr. 4
Item 2. Sharebots a good title? Why/why not? 3 pt OCR (full, partial, little/no comprehension)	Item 4. Describe appearance of female blue crab carrying eggs 2 pt OCR (acceptable/unacceptable)
Item 4. Is herd a good description for the group of robots? 3 pt OCR (full, partial, little/no comprehension)	Item 5. Why does blue crab hide after molting? 2 pt OCR (acceptable/unacceptable)
Item 7. Good idea to product more complex robot societies? 2 pt OCR (acceptable/unacceptable)	N/A

ANSWER KEY AND SCORING GUIDE FOR OFFLINE READING MEASURE **Sharebots (Grade 8)**

1. B

2. Scoring Guide – Task: *Do you think "The Sharebots" is a good title for the article? Explain why or why not, using information from the article.*

Evidence of full comprehension:

- These responses provide an opinion about the title and provide appropriate evidence from the article that directly supports the idea of robots sharing with each other, cooperating with each other, or working as a group.

Evidence of partial or surface comprehension

- These responses provide an opinion about the title and support their opinion with a text-based generalization. Or responses at this level may cite evidence from the article that relates to the development of the robots or to the physical activities that can be performed by robots.

Evidence of little or no comprehension

- These responses may provide a yes or no answer, but do not cite appropriate evidence from the article in support of their answer. Their responses display little or no understanding of the text's overall purpose or central idea.

3. C

4. Scoring Guide – Task: *Maja Matarić describes her group of robots as a "herd." Based on what you know about the behavior of animals in herds, do you think this is a good description? Explain your answer by using examples from the article and what you know about herds.*

Evidence of full comprehension

- These responses explain why herd is or is not a good description for a group of robots. They use explicit information from the article and their prior knowledge to make a clear connection between robot behavior and herd-like behavior.

Evidence of partial or surface comprehension

- These responses provide an example of herd-like behavior that is similar to a behavior exhibited by robots, but do not connect it to a specific robot behavior. Or, they may provide an example of robot behavior that is (or is not) similar to herd-like behavior. However, at this level, the connection between robot behavior and herd-like behavior is general or circular (e.g., Animals in herds follow one another just like sharebots do.).

Evidence of little or no comprehension

- These responses may provide a yes or no answer, but they fail to provide any example of robot behaviors from the article, and they do not describe a herd-like behavior that is similar to the behaviors exhibited by the robots. Also, they may merely define "herd."

Examples of herd-like behavior exhibited by the robots:

- following each other
- communicating with each other
- letting each other know that a puck has been found
- working toward a common goal
- competing with each other

5. B

6. A

7. Scoring Guide – Task: *Do you think it is a good idea for Matarić to "produce more complex robot societies"? Support your opinion with information from the article.*

Acceptable:

- These responses provide an opinion about Matarić's plans that reflect at least general understanding of the kinds of improvements she would like to make. Specific evidence from the article is cited in support of the opinion.

Unacceptable:

- These responses may provide a "yes" or "no" response, but they do not demonstrate understanding of Matarić's plans to continue developing and improving what the robots can do. No evidence, or inappropriate evidence may be cited from the article.

Blue Crabs (Grade 4)

1. A

2. C

3. A

4. Scoring Guide – Task: *Describe the appearance of a female blue crab that is carrying eggs.*

Acceptable:

- Responses mention that she carries an orange-brown sponge or she has eggs on her abdomen or underside. For example: "Long hairs with glue holding 2 million eggs."

Unacceptable

- Responses contain inappropriate or incorrect information. For Example: "She has a sack of eggs in her claws."

5. Scoring Guide – Task: *Why does a blue crab hide after molting?*

Acceptable:

- Responses indicate that the blue crab is helpless without its shell and cannot defend itself, so it hides. Also accept responses that only mention soft shell, or the need to protect themselves.

Unacceptable

- Responses give reasons that are contradicted or not supported by information in the text, such as, "Blue crabs hibernate after their soft shells fall off." Or, "Blue crabs feel funny, so they hide."

6. D

NAEP Questions Tool:

<http://nces.ed.gov/nationsreportcard/itmrlsx/search.aspx?subject=reading>