THE ONLINE RESEARCH AND COMPREHENSION ASSESSMENT (ORCA) PROJECT

PROJECT REPORT #1

The New Literacies of Online Research and Comprehension: Rethinking The Reading Achievement Gap

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Abstract

Is there an achievement gap for online reading ability based on income inequality that is separate from the achievement gap in traditional, offline reading? This possibility was examined between students in an economically advantaged school district (West Town) and an economically challenged (East Town) school district (N = 256). Performance based assessments were used within a simulation of the Internet developed as part of a larger project. Seventh graders completed two online research and comprehension assessments (ORCAs), which evaluated four skill areas (Locate, Evaluate, Synthesize, and Communicate) and two knowledge domains in science. Students also completed an assessment of prior domain knowledge and a short Internet Use Survey. Standardized state reading and writing test scores served as measures of offline literacy skills. Results indicated that there was a significant achievement gap favoring West Town students in: offline reading scores, offline writing scores, and online research and comprehension scores. A significant gap persisted for online research and comprehension after we conditioned on pre-test differences in: offline reading, offline writing, and prior knowledge scores. The survey indicated that West Town students had greater access to the Internet at home and were required to use the Internet more in school. These results suggest that a separate and independent achievement gap existed for online reading, based on income inequality. Current estimates of this gap, which rely solely on measures of offline reading, may under represent the true nature of the U.S. reading achievement gap in an online age. Policy implications are explored.

Keywords: reading, comprehension, achievement gap, science, new literacies

The New Literacies of Online Research and Comprehension:

Rethinking The Reading Achievement Gap

Education and opportunity have long been linked to public policy in the United States (Brown v. Board of Education, 1954; Isaacson, 2003; Common Core State Standards Initiative [CCSS], 2012). Intertwined with this history, the ability to read at high levels has always been considered important, permitting an essential pathway to advancement for everyone, especially the least privileged (cf. Chall, 1970; Huey, 1908; Mann, 1855).

Despite attempts at policy remedies, a substantial gap based on income inequality continues to exist in students' reading achievement levels (National Center for Educational Statistics [NCES], 2011a; 2013). Some evidence indicates that it is growing, over time (Reardon, 2013). In a society that professes egalitarian ideals and equal opportunity through education, a reading achievement gap based on income inequality should be a concern for every citizen.

Reading has been shifting from page to screen (Goldman, Braasch, Wiley, Graesser, & Brodowinska, 2012), but analyses of reading achievement gaps have only evaluated differences in offline reading (cf. NCES, 2011a; Reardon, 2013; Reardon & Galindo, 2009). Is there an achievement gap in online reading ability based on income inequality that is independent of the achievement gap in traditional, offline reading? If so, the actual reading achievement gap would be greater than we recognize today. The current study explores this issue, one that is important to public policy, assessment, and instruction during new, online times.

Perspectives

New Literacies: A Dual Level Theory

Ever since the term "new literacies" was first used by Buckingham (1993) it has represented many different perspectives (cf. Baker, 2010). Typically, this term suggests that literacy is

rapidly changing and transforming as new information and communication technologies emerge, and as additional discourses, social practices, and skills are required to make use of these technologies (e.g., Baker, 2010; Gee, 2007; Lankshear & Knobel, 2006). With the Internet, literacy is not just new today; it is new every day, as additional technologies for literacy regularly and rapidly evolve online.

The rapidly evolving nature of literacy presents an important challenge for theory development. How can adequate theory be developed when the object that we seek to study is itself ephemeral, continuously being redefined by a changing context? Recently, a dual-level theory of New Literacies has been proposed to respond to this problem (Author, 2013). It conceptualizes new literacies on two levels: uppercase (New Literacies) and lowercase (new literacies).

New Literacies, as the broader concept, benefits from work taking place in the multiple, lowercase dimensions of *new literacies,* where rapid changes are more easily studied and identified. When common findings across multiple, lowercase perspectives are integrated into a broader *New Literacies* theory we are likely to have results that are more stable over time. The greater stability of New Literacies theory may provide theoretical direction to inform research into the more rapidly changing contexts at lowercase levels.

One of several principles of uppercase New Literacies is that the Internet makes new social practices possible with technologies such as instant messaging, social networks, blogs, wikis, and email, among others (cf. Greenhow, Robelia, & Hughes, 2009; Lewis & Fabos, 2005). Thus, this study situated online research and comprehension assessments (ORCAs) within a social network that included some of the new social practices associated with these technologies.

The New Literacies of Online Research and Comprehension

The new literacies of online research and comprehension (Author, 2013; Kingsley & Tancock, 2014) is one of many lowercase perspectives of new literacies. Initially the term "online reading comprehension" was used (cf. Castek, 2008; Coiro, 2011; Coiro & Dobler, 2007; Henry, 2007; Author, 2004). Unfortunately, the term has led to some confusion about whether or not anything is really "new" during online comprehension. Perhaps this is because people first encountering the construct assumed a limited online reading activity such as the reading of a single web page.

There are many situations in which we might read online, such as when we read an email message, an online newspaper, or a single web page. Isolated reading acts, such as these, do not differ substantially from offline reading comprehension except for the online context; there is little that is "new." Usually, however, online reading does not take place within isolated contexts. Instead, it occurs within a rich and complex process of inquiry and problem solving as we seek answers to questions and use the Internet to comprehend and learn (Castek, 2008; Coiro & Dobler, 2007; Goldman, Braasch, Wiley, Graesser, & Brodowinska, 2012).

Recently, a more precisely descriptive term, "the new literacies of online research and comprehension," has been used (Author, 2013; Kingsley & Tancock, 2014). It makes the somewhat distinctive nature of online research and comprehension easier to understand, since online research requires skill with additional technologies (e.g., search engines, text messaging, and note taking tools) and also requires additional social practices (e.g., using a search engine to locate information about the creator of a web site to help determine the reliability of the information.)

This theory seeks to describe what happens when we read to conduct online research and comprehend information as we learn. It suggests that at least five processing practices occur

during online research and reading comprehension: 1) reading to define important questions or problems (Taboada & Guthrie, 2006); 2) reading to locate information (Lawless & Schrader, 2008; Kuiper & Volman, 2008); 3) reading to evaluate information (Sanchez, Wiley, & Goldman, 2006); 4) reading to synthesize information (Goldman, Wiley, & Graeser, 2005; Jenkins, 2006); and 5) reading and writing to communicate information (Greenhow, Robelia, & Hughes, 2009). These five categories are thought to comprise most of the skills, strategies, dispositions, and social practices that are distinctive to online research and comprehension in a complex layering of both offline and online reading that we are still seeking to fully understand (Authors, in press). We used this lowercase theory of online research and comprehension to inform the operational definition for online reading in the current study. Specifically, we evaluated students' ability to locate, evaluate, synthesize, and communicate information during an online research task.

Previous Research

Achievement Gaps in the U. S.

Offline reading. On both the 2011 and 2013 National Assessment of Educational Progress (NAEP) for Reading, there was a difference of two-thirds of a standard deviation in scaled reading scores between eighth grade students eligible for the National School Lunch Program and those who were not. The difference favored economically advantaged students. This is roughly the difference between scores at the 25th percentile and the 50th percentile (See NCES, 2011a; 2013) or two to three years of schooling in the middle school and high school years (See Hill, Bloom, Black, & Lipsey, 2008).

Even more troubling, the offline reading achievement gap based on income inequality is increasing (Reardon, 2011; 2013; Bailey & Dynarski, 2011). Between 1976 and 2001, the

achievement gap in reading increased by nearly 40% for children raised in families with incomes at the 10th percentile, as compared to children raised in families with incomes at the 90th percentile (Reardon, 2011). Using a 10th percentile - 90th percentile family income metric, the achievement gap is nearly 1.25 standard deviation units, or roughly equivalent to three to six years of schooling in the middle school and high school years (Reardon, 2011).

To put this gap in comparative terms, the gap between rich and poor is now approximately double the black-white achievement gap in reading, a gap that has been declining during the same period (Reardon, 2011). Particularly troubling is that income inequality in the United States is also increasing (Congressional Budget Office, 2007), suggesting that the offline reading achievement gap may get even larger over time.

Reading is an important gateway to learning and success in school (Anderson, Hiebert, Scott, & Wilkinson, 1985). Children who fall behind in reading achievement are unlikely to catch up later (Annie E. Casey Foundation, 2010; Snow, Burns, & Griffin, 1998). The result of falling behind in reading is a loss of opportunity, both for individuals and for our larger society (NCES, 2013). The persistent achievement gap in reading, based on income inequality, may contribute to stagnating economic mobility in the United States; economic mobility is now less than in Europe and other developed nations (Chetty, Hendren, Kline, & Saez, 2014).

Science. In a global economy, the preparation of students in science and related fields is essential (National Research Council, 2007; The President's Council of Advisors on Science and Technology, 2010). Both human and economic advances may be jeopardized by the large and increasing gap in science achievement among students who attend school in the United States (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011).

On the 2009 NAEP in Science, there was a difference of nearly one standard deviation between eighth grade students eligible for the National School Lunch Program and those who were not (NCES, 2009). This represents a difference between scoring at the 20th percentile and the 50th percentile (NCES, 2011d). The current study was conducted within the discipline of science because science is increasingly important (National Research Council, 2011) and because achievement gaps based on income inequality were also found in this subject area.

Writing ability. Writing to communicate information is one aspect of online research and comprehension. We write to acquire new information, to ask questions about what we find, and to share what we have learned online with others (Britt & Gabrys, 2001; Author, in press). There was a difference of .77 standard deviation units in offline writing performance between eighth graders in the United States who were eligible for a free or reduced price lunch and those who were not (NCES, 2011b). In this study, we wanted to distinguish between offline reading comprehension and online research and comprehension, which includes online communication skills with writing. Thus, we conditioned on offline writing in our statistical models. This extends previous work that studied differences between online and offline reading comprehension (Coiro, 2011) but did not consider offline writing ability as a potentially confounding factor.

Online Research and Comprehension

The ability to comprehend 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, Braasch, Wiley, Graesser, & Brodwinska, 2012). Recent studies have shown that online research and comprehension is not isomorphic with offline reading comprehension. There appears to be a complex relationship between the offline and online skills

that are required when one moves from traditional texts to conducting research and comprehending information in an online environment (Afflerbach & Cho, 2009; Coiro & Dobler, 2007; Hartman, Morsink, & Zheng, 2010). Afflerbach & Cho (2009) reviewed 46 studies that focused on reading strategy use during Internet and hypertext reading. Their analysis showed evidence of strategies that "...appeared to have no counterpart in traditional reading" (p. 217). Many strategies centered around a reader's ability to apply methods to reduce their levels of uncertainty, while navigating and negotiating appropriate reading paths in a shifting problem space (see also Cho, 2010; Zhang & Duke, 2008).

Coiro & Dobler (2007) found that online research and comprehension involved the use of offline reading comprehension skills, but that it was more complex and included a number of additional skills. This supports an earlier finding that there was a smaller than expected correlation between scores on a state reading comprehension assessment and an assessment of online research and reading comprehension (Author, 2005). Another study used a regression model to predict online reading performance (Coiro, 2011). It conditioned on offline reading and prior knowledge scores and found that an additional 16% of variance was accounted for by knowing students' previous online research and comprehension ability. This also indicates that additional skills, beyond those required for offline reading, are required for online research and comprehension.

Finally, case studies and videos of online reading show that students who score low on state reading assessments sometimes perform at unexpectedly high levels on tasks of online research and comprehension (Authors, 2011; Author, 2007). While we do not fully understand the source of the differences between offline reading comprehension and online research and comprehension, there is considerable evidence that the two are not identical.

Why is a difference between offline reading and online research and comprehension important? If the two were isomorphic, an identical achievement gap based on income inequality would be predicted. The fact that the two appear somewhat different suggests that a separate and independent achievement gap could exist for online research and comprehension. Preliminary work has suggested that a gap in online research and comprehension ability exists based on income inequality (Henry, 2007). However, that study did not determine if the gap was independent of offline reading ability. If a separate and independent gap exists, it would suggest that the achievement gap reported for offline reading underrepresents the magnitude of the challenge.

Internet Access At Home

According to the National Telecommunications and Information Administration (2010), 32% of all households with incomes of less than $15,000 had a minimum level of broadband access (200 kbps) compared to 90% of families with incomes over $150,000. A home access gap is also reported by the Pew Research Center (2011), which shows that 35% of lower-income households (less than $30,000 in household income per year) do not use the Internet, compared to only 2% of upper-income households (more than $75,000 in household income per year) in the U.S.

The lack of Internet access at home may be one important source of an achievement gap in online research and comprehension. Students who have fewer opportunities and experience with online research and comprehension at home are likely to be behind in these skills when they come to school. When compounded with lower achievement levels in offline reading between these same two groups of students, as demonstrated by NAEP (NCES, 2013) data, students who come from lower income families may be doubly disadvantaged (Author, 2013). In this study,

we asked students from both districts to report on their Internet access at home and at school.

Prior Knowledge

The knowledge that readers bring to reading plays an important role in their comprehension of offline text (e.g., Kintsch, 1998; McNamara & Kintsch, 1996; Voss & Silfies, 1996), and is likely to play a similar role during online research and comprehension. Information that is stated in a text is often insufficient for the construction of a coherent mental representation of the situation, requiring the contribution of a reader's prior knowledge (Kintsch, 1998; McNamara et al., 1996; Voss and Silfies, 1996). This is particularly apparent with expository, or informational text materials (Afflerbach, 2007; Chi, Feltovich, & Glaser, 1981). In this study, we wanted to be able to rule out pre-test differences in prior knowledge as the source of differences between students in the two districts. Thus, our statistical models condition on prior domain knowledge of the science topics relevant to our online research and comprehension assessment.

Assessments of Online Research and Comprehension

Previous assessments of online research and comprehension have taken place within the dynamic reality of the Internet (Coiro, 2011; Castek, 2008; Henry, 2007). However, each suffered from content stability issues, since it was possible for target websites to change during data collection. As a result, an assessment used at one time was not always comparable to the same assessment used at another time.

Several lines of work recently have emerged to solve the content stability issue in the assessment of online reading, problem solving, and inquiry: PISA's Digital Reading Assessment (OECD, 2011), PIAAC's Problem Solving in Technology-rich Environments (PIAAC Expert Group in Problem Solving in Technology-Rich Environments, 2009), Global Integrated

Scenario-based Assessments, or GISA (Sabatini, O'Reilly, Halderman & Bruce, 2014), ePIRLS (Mullis & Martin, 2013), and the Online Research and Comprehension Assessments, or ORCAs (Authors, 2009). This study is part of the latter initiative, which developed performance based ORCAs in knowledge domains associated with health and human body systems, a common curriculum area in science for seventh graders in the U. S.

The ORCA project has developed several performance based formats, including simulations of the Internet (See Authors, 2012 and the video available at: http://youtu.be/WTI1qxbRwDY). The ORCA-Simulation format evaluates students' ability in online research and comprehension within a closed and stable information space, a simulation of the Internet. We used this format to evaluate the research questions for this study:

1. Is there an achievement gap in offline reading comprehension between seventh grade students attending an economically advantaged and an economically challenged school district?
2. Is there an achievement gap in online research and comprehension between seventh grade students attending an economically advantaged and an economically challenged school district?
3. When we condition on pretest differences in offline reading ability, prior domain knowledge, and offline writing ability, is there a separate and independent achievement gap in students' ability to conduct online research and comprehend information in science?

Method

Participants

Participants came from seventh grade cohorts in two schools in two different districts. The

districts were in a northeastern state ranked fourth in the U.S. in median family income (U.S. Census Bureau, 2012). In this state, a District Reference Group (DRG) system is used to classify districts by socioeconomic level (See Connecticut Department of Education, 2006). These DRGs include eight levels of economic status, ranging from A (high) to I (low). The DRG system was used to select a convenience sample of two districts, one from within a higher level DRG and one from within a lower level DRG. One district, referred to as West Town, came from the second highest level (B) and the other, referred to as East Town, came from the second lowest level (H).

Several economic and technology indicators for each district are presented in Table 1. The median family income for West Town was twice that of East Town, and the percentage of students who were eligible for free/reduced price lunches was nearly 17 times greater for East Town compared to West Town. Both schools had comparable wifi capabilities and similar profiles of Internet connected computers with high or moderate power available to students. The middle school at East Town had a slightly better ratio of students per instructional computer connected to the Internet (3.3) compared to the middle school at West Town (3.7).

TABLE 1 ABOUT HERE

We deliberately selected these two districts because each had only a single middle school. We permissioned all seventh grade students in each school. This ensured that participating students closely represented the larger community in each district. Ninety percent of all seventh grade students in both districts returned parental permission forms, 174 students from West Town and 162 students from East Town. The seventh grade level was selected since this is often

the level where learning disciplinary information becomes especially important to academic success (Shanahan & Shanahan, 2012).

On the first day of the study in West Town, we experienced technology issues during the first two testing sessions. As a result, 36 students in West Town only completed the assessment "Are Energy Drinks Heart Healthy for Adolescents?" ("Energy Drinks"). Another 30 students only completed the assessment "Can Chihuahua Dogs Cure Asthma?" ("Asthma"). In East Town, 10 students were only able to complete the assessment "Energy Drinks" (and not "Asthma") and four were only able to complete the assessment "Asthma" (and not Energy Drinks"). Students who only completed one of the two assessments were dropped from the primary analyses used for this study. This resulted in a total loss of 66 students from West Town and 14 students from East Town. They were, however, included in a set of secondary analyses that helped to evaluate the loss of data.

The final sample for the primary analyses in this study consisted of 256 seventh grade students in two districts who completed both assessments: "Energy Drinks" and "Asthma." We know that students with special education services and students who spoke a language at home other than English were in our population, but we did not have access to these demographic data. At the middle school in West Town, 0.8% of students were not fluent in English and received special services in this area and 8.4% of students were identified as receiving special education services. Seven percent of students in the East Town middle school were not fluent in English and received special services in this area and 12.9% of students were identified as receiving special education services. In the final sample, 108 students came from the economically advantaged district (West Town), including 58 girls and 50 boys, and 148 students came from the economically challenged district (East Town), including 67 girls and 80 boys. Information

on the gender for one student in East Town was missing.

Offline Reading Comprehension

Scores from the state reading assessment, administered two months prior to this study, measured traditional, offline reading comprehension (Connecticut State Board of Education, 2010). This assessment contained no items that measured online research and comprehension skills. We obtained scores for 238 of the 256 students used in this study: 103 out of 108 students from West Town and 135 out of 148 students from East Town.

The state reading assessment provided a combined scaled score of the ability to understand nonfiction English prose as well as narrative passages on a variety of topics (Connecticut State Board of Education, 2010). The reliability estimate for this instrument is 0.95 using Cronbach's alpha (Hendrawan & Wibowo, 2011). Mean scaled scores on the state reading assessment for participating students were: 282.60 for West Town and 215.10 for East Town. The mean scaled score in reading for participating West Town students fell within the highest of five score bands (Advanced), while the mean scaled score in reading for participating East Town students fell within the middle of five score bands (Proficient).

Prior Domain Knowledge Of The Topic

Prior domain knowledge of the research topic was evaluated using idea unit analysis, an approach with demonstrated reliability (Wolfe & Goldman, 2005). Prior knowledge scores for both topics were obtained from all 256 students used in this study. We gathered data on prior domain knowledge online before students began each research task. Students were prompted to enter all that they knew about the topic in a window on their laptop. After every 15 seconds, they were prompted by the system to enter additional information that they knew about the topic. When 15 seconds went by without an entry, a button became available that said, "I don't know

anything else." Prior knowledge entry concluded when students selected this button and began the research task. Idea unit analysis (the number of propositions provided by a student) was conducted on all entries. Each proposition received one point. Two scorers were trained to 90% accuracy with a sample set; disagreements were resolved through discussion. They then scored all prior knowledge entries.

Offline Writing Ability

Scaled scores from the state writing assessment, administered two months prior to the study, measured offline writing ability. No items specifically measured online writing ability. State writing assessment scores were obtained for 249 of the 256 students used in this study: all of the 108 students from West Town and 141 out of 148 students from East Town. The offline writing assessment included two tests, the Direct Assessment of Writing (DAW), a performance based assessment, and Editing & Revising (Connecticut State Board of Education, 2010). The reliability estimate for this instrument is 0.89, using Cronbach's alpha (Hendrawan & Wibowo, 2011). For scoring, there was a decision consistency reliability of 0.96 and a decision accuracy reliability of 0.94 (Hendrawan & Wibowo, 2011).

Online Research and Comprehension Assessments (ORCAs).

Performance based assessments were used to measure online research and comprehension ability. Two online simulations of the Internet, with structurally similar scenarios, presented problems in science within a social network for students to solve using online information and various Internet tools. Problems came from the domains of health and human body systems. In the first scenario ("Energy Drinks") a programmed, student avatar asked students to check their email inbox to locate a message from the Principal of a middle school. (See Figure 1.) The Principal indicated that the President of the School Board was concerned about having energy

drinks at school. Her email message asked students to conduct research on how energy drinks affected heart health using the Internet, and then to send an email to the School Board President with a short report of the findings.

FIGURE 1 ABOUT HERE

The second scenario, "Asthma," presented students with a wiki used in a science classroom. The student avatar asked students to read the information that had been posted on a classroom wiki about asthma. Then, the avatar directed students to conduct research online and determine whether Chihuahua dogs can cure asthma, a popular urban legend in some cultures. Finally, after completing the research, the avatar asked students to use their findings to revise the class's asthma wiki page.

An extensive collection of web pages was imported into a closed space on the Internet for ORCA-Simulation assessments. An internal search engine ("Gloogle") was created to locate web pages that had been imported. The ORCA-Simulation assessment also included closed email and wiki systems, as well as a closed social network system with texting/chat capability. Fictitious teachers, principals, and students, represented with additional avatars, prompted each student throughout the research process within the social network interface via text messages. Each assessment followed a parallel scenario structure, where students were asked to locate four different websites, synthesize information across them, and critically evaluate one of the sites. Students were then asked to write a short report in either an email message or on the class wiki, depending on the scenario.

Scoring. Each scenario formed a testlet (Wainer, Bradlow, & Wang, 2007), called a LESC

(Locate, Evaluate, Synthesize, and Communicate), and students were evaluated with respect to each of these four skill areas as well as a total score. Each LESC contained 16 total score points (see Table 2), with four points assigned to each skill area. Each of the 16 score points evaluated an online research and comprehension skill that had been identified from previous research and through discussions with researchers in this area.

TABLE 2 ABOUT HERE

Each of the four skill areas (Locate, Evaluate, Synthesize, Communicate) included three process skills and one product skill. Four experts in online research and comprehension scaled the three process skills by the likely order of difficulty, so that each skill was considered more difficult than the one before. Each of the four product skills was considered to be a culminating task for its given area, and therefore was intended to be the most difficult of the four score points in that area.

The LESC components did not appear in a strictly linear sequence (e.g., the assessment did not begin with Locate tasks, followed by Evaluate tasks, etc.), nor did the four skills that were evaluated within a component dimension. Instead, a more logical and natural sequence of events developed within the scenario. The one exception was the evaluation sequence, which asked students to evaluate one of the web pages in four areas with sequential requests from the student avatar (See Table 2 for the four skills that were evaluated.)

A data capture system was developed to record and track students' online reading decisions for subsequent scoring. Video screen captures were also used for a richer interpretation of student performance, as well as a backup for the data capture system.

Four graduate students served as scorers, working in pairs for each topic. They evaluated performance following a common rubric for each of the 16 score points. Each score point was evaluated using a binary (i.e., 0 or 1) scoring system. Scorers were initially trained on a common set of 10 scenarios. Then, they were each tested for accuracy on another set of 10 scenarios, and were required to reach 90% inter-rater agreement for each one of the 16 score points before being allowed to score the actual student assessments. The scoring pairs compared their scoring at several points throughout to reevaluate their reliability of scoring decisions. Each time this reliability check was conducted, inter-rater reliability met or exceeded 90% for each score point, within each scenario. Any disagreements that did appear were resolved through discussion. The ORCA total score consisted of 16 score points from each of two LESC testlets for a total of 32 possible score points. The ORCA total score was used as a measure of students' ability to conduct Internet-based research and comprehend the information they encountered.

Dimensionality. The unidimensionality of the ORCA scale was investigated through principal components analysis. It was found that 78.9% of variance in ORCA scores was explained by the first principal component, indicating that a single composite score should adequately summarize the information in the ORCA assessment.

Reliability estimates. Reliability of the ORCA was evaluated using Cronbach's alpha reliability coefficient, a measure of internal consistency. The combined (32 point) ORCA assessment demonstrated good reliability with Cronbach's alpha = .89. Reliability was also high for each individual (16 point) LESC assessment scenario: Energy Drinks (Cronbach's alpha = .83) and Asthma (Cronbach's alpha = .79).

Survey of Internet Use At Home And School

Students completed a brief survey including two items. The first item asked, "How many

computers are in your home that are connected to the Internet?" Possible responses included: 0, 1, 2, 3, and 4 or more. Due to sparse data in the upper categories, responses were collapsed into four categories: 0, 1, 2, and three or more. Complete responses were obtained from 101 students from West Town and 144 students from East Town.

The second item asked, "How often have you been required to use the Internet at school?" Possible responses included: Never; Less than once a week; Once a week; A few times each week; and Once a day. Responses to the second item were collapsed into three categories: Never; Once a week or less; and More often than once a week. Complete responses were obtained from 100 students from West Town and 142 students from East Town.

Administration

An administration protocol for the online research and comprehension assessments (ORCAs) was developed, pilot-tested, and revised before it was used in this study. Two test administrators conducted the assessments in separate classes at the same time, with 25 wireless laptops each. The order of assignment to the research problems (Energy Drinks and Asthma) was randomized.

Analyses

Evaluating An Achievement Gap in Offline Reading

The first analysis evaluated whether or not an offline reading achievement gap existed between mean scores of students from the two districts on the state reading assessment. For this analysis, an independent samples t-tests was conducted.

Evaluating An Achievement Gap in Online Research and Comprehension

To identify whether there was an achievement gap in online research and comprehension, a second analysis was conducted on the ORCA total score, comparing the difference between

mean scores for students in each district. For this analysis, an independent samples t-tests was conducted.

We also conducted separate independent samples t-tests on each LESC component (Locate, Evaluate, Synthesize, and Communicate), for each research problem ("Energy Drinks" and "Asthma"), comparing the difference between mean scores for students in each district. These analyses evaluated whether the online reading achievement gap existed separately in each of the components of online research and comprehension within each research problem. Thus, eight tests of mean differences were conducted. In order to account for multiple comparison issues, p-values were computed using a Bonferroni correction for each test. The Bonferroni correction is the simplest and most conservative approach to controlling the family wise error rate (Abdi, 2007). Individual p-values and confidence intervals reported in the text are uncorrected. However, as noted in Table 3, all mean differences were statistically significant even after application of the Bonferroni correction. Finally, mean differences were computed with the data collapsed, respectively, across LESC type and research problem. Since differences at a lower level of aggregation remained significant after applying a Bonferroni correction, no additional correction for multiple comparisons was necessary for the corresponding t-tests.

Evaluating Whether The Achievement Gap In Online Research and Comprehension Persisted After Conditioning On Other Variables

The third analysis evaluated whether an achievement gap in online research and comprehension persisted after conditioning on other possible determinants of ORCA scores. To answer this question, we estimated a multiple regression analysis model that tested for mean differences on total ORCA scores by district, while conditioning on three covariates: scaled scores on the state assessment of offline reading comprehension, total prior domain knowledge

of the two topics, and scaled scores on the state writing assessment. We also estimated a separate multiple regression analysis model for each research problem ("Energy Drinks" and "Asthma") in order to evaluate the consistency of findings across different topic areas, using students who had completed both research problems.

Evaluating missing data. We estimated two additional regression models to evaluate the potential consequences of missing data due to the technology problems that we experienced, especially on the first day of testing. First, we estimated a multiple regression analysis model that tested for mean differences on Energy Drinks score by district, using scores on this assessment from each student who completed it, including those who only completed a single assessment. This model conditioned on three covariates: scaled scores on the state assessment of offline reading comprehension, prior domain knowledge for Energy Drinks, and scaled scores on the state writing assessment.

Second, we estimated a multiple regression analysis model that tested for mean differences on Asthma score by district, using scores on this assessment from each student who completed it, including those who only completed a single assessment. This model conditioned on three covariates: scaled scores on the state assessment of offline reading comprehension, prior domain knowledge for Asthma, and scaled scores on the state writing assessment.

Home and School Internet Use Survey Items

Two analyses were conducted on responses to the survey questions, using chi-square tests of association:

1. "How many computers are in your home that are connected to the Internet?"
2. "How often have you been required to use the Internet at school?"

The first evaluated the relationship between home Internet access and the district that a student

attended, and the second evaluated the relationship between the frequency of school Internet use and the district that a student attended.

Results

Table 3 presents the means, standard deviations (SD), and Hedges' g values for the state reading score, the total ORCA score for both West and East Town students, the total scores for each of the four components (Locate, Evaluate, Synthesize, and Communicate), and the scores for each of the two topics ("Energy Drinks" and "Asthma.")

TABLE 3 ABOUT HERE

Evaluating The Offline Reading Achievement Gap

Table 3 shows that there was a statistically significant difference in mean scores on the offline reading measure between students in the two districts: t (182.75) = 13.81, $p \leq .0001$ with a 95% confidence interval of 57.86 to 77.15. The estimated magnitude of the difference was large (Hedges' g = 1.87). These results are generally consistent with the results found at the national level, where a large and significant achievement gap in traditional offline reading exists based on income inequality (NCES, 2011a; 2013).

Evaluating The Online Reading Achievement Gap

Comparisons of the online reading measures (See Table 3) revealed a statistically significant difference in mean scores between the districts for the ORCA total score, t(193.52) = 11.22, $p \leq .001$ with a 95% confidence interval of 6.06 to 8.64. This also was true for each assessment individually "Energy Drinks": t(205.20) = 7.65, $p \leq .001$ with a 95% confidence interval of 2.12 to 3.59 and "Asthma": t(186.39) = 12.19, $p \leq .001$ with a 95% confidence

interval of 3.77 to 5.23. In all cases the mean score for students from the economically advantaged district was higher. The estimated effect sizes (Hedges' g) were large: 1.47 for the combined assessment, 0.994 for the "Energy Drinks" assessment, and 1.6 for the "Asthma" assessment.

In addition, comparisons of the LESC components of the online reading measure revealed a statistically significant difference in mean scores between the districts for each of the four components: Locate: $t(200.31) = 7.68$, $p \leq .0001$, with a 95% confidence interval of 1.53 to 2.59; Evaluate: $t(180.68) = 6.77$, $p \leq .0001$, with a 95% confidence interval of .710 to 1.29; Synthesize: $t(254) = 10.40$, $p \leq .0001$, with a 95% confidence interval of 2.08 to 3.06; and Communicate: $t(183.53) = 9.68$, $p \leq .0001$, with a 95% confidence interval of 1.35 to 2.04. In all cases the mean score for students from the economically advantaged district was higher. The effect size was large for each component: Locate (Hedges' g = 1.00); Synthesize (Hedges' g = 1.31); Communicate (Hedges' g = 1.29); and Evaluate (Hedges' g = .897).

Component mean scores were also significantly different for both Energy Drinks and Asthma, favoring students in West Town in all cases. For Energy Drinks: Locate: $t(218.1) = 4.44$, $p \leq .0001$, with a 95% confidence interval of .397 to 1.03; Evaluate: $t(191.16) = 3.25$, $p \leq .0001$, with a 95% confidence interval of .119 to .486; Synthesize: $t(226.62) = 6.01$, $p \leq .0001$, with a 95% confidence interval of .671 to 1.33; and Communicate: $t(254) = 7.50$, $p \leq .0001$, with a 95% confidence interval of .585 to 1.04. For Asthma: Locate: $t(254) = 8.82$, $p \leq .0001$, with a 95% confidence interval of 1.03 to 1.66; Evaluate: $t(254) = 7.72$, $p \leq .0001$, with a 95% confidence interval of .509 to .892; Synthesize: $t(221.58) = 10.2$, $p \leq .0001$, with a 95% confidence interval of 1.27 to 1.87; and Communicate: $t(254) = 8.07$, $p \leq .0001$, with a 95% confidence interval of .655 to 1.11. The estimated effect sizes (Hedges' g) for the component

scores for "Energy Drinks" ranged from moderate to large: .573 for Locate, .430 for Evaluate, .763 for Synthesize, and .944 for Communicate. The estimated effect sizes (Hedges' g) for the component scores for "Asthma" were all large: 1.11 for Locate, .976 for Evaluate, 1.30 for Synthesize, and 1.02 for Communicate.

Evaluating A Separate and Independent Achievement Gap in Online Research and Comprehension

A multiple linear regression model was used to test if differences in total ORCA scores by district persisted when we conditioned on pre-test differences in state reading assessment scores, total prior knowledge scores, and state writing assessment scores. To provide context for interpreting the coefficients in the regression model, we first present bivariate correlations between all predictors in the model in Table 4. We then present statistics relating to the regression analysis in Table 5.

TABLE 4 ABOUT HERE

TABLE 5 ABOUT HERE

Results of the regression model showed that, taken together, school district, state reading scores, prior knowledge scores, and state writing scores accounted for 53% of the variance in total ORCA scores. The regression coefficients associated with state reading and state writing scores were both positive and statistically significant. Interestingly, there was no significant association of prior knowledge scores with ORCA scores once state reading and writing scores

were accounted for. Similar results were found previously by Coiro (2011).

Our primary interest was to determine if the mean total ORCA scores, using scores from students who completed both research problems, were significantly different between the two districts when we conditioned on pretest scores on the state reading assessment, prior knowledge scores, and state writing assessment scores. Conditional on the other variables in the model, students in East Town scored, on average, 2.7 points lower than did students in West Town. We standardized this difference by computing Hedges' g, with the adjusted mean difference between districts in the numerator and the unconditional standard deviation of ORCA scores (pooled across districts) in the denominator. The resulting estimate is 0.54. This achievement gap for online reading cannot be explained by differences between the districts in average state reading scores, state writing scores, and prior knowledge scores.

Evaluating the loss of data. As noted previously, some students were not included in our primary analysis since they only completed one research task due to technology issues. We conducted a secondary analysis that included these data to evaluate the consequences of this loss (See Table 5.) When we conditioned on state reading scores, prior knowledge scores, and state writing scores for all students who completed "Energy Drinks" and/or "Asthma" separately, including those students who completed only one research problem, we found that all four predictors, taken together, accounted for 44.2% of the variance in ORCA score for the Energy Drinks LESC and 46.3% of the variance in ORCA score for the Asthma LESC. These analyses, including students who completed both research problems as well as those who only completed a single research problem, used a 16 point scale rather than a 32 point scale, since the scores from only a single research problem were used in each case. Conditional on state reading scores, prior knowledge scores, and state writing scores, students in East Town scored, on average, 1.60 (out

of 16) points lower than students in West Town for Energy Drinks and 1.39 (out of 16) points lower than students in West Town for Asthma. Both mean differences were significant ($p \leq .001$). Hedges g was moderate in size both for Energy Drinks (0.52) and for Asthma (0.54). These estimates for an achievement gap in online reading based on income inequality cannot be explained by differences between the districts in average state reading scores, state writing scores, and prior knowledge scores.

Home and School Internet Use Survey Items

Tables 6 and 7 present responses to the two survey questions about online access at home and at school for West town and East town students. Results indicate that West Town students had greater access to computers at home than East town students, and this difference in access is statistically significant. Furthermore, West town students were also more likely than East Town students to have been required to use the Internet at school. Differences were again statistically significant.

TABLE 6 ABOUT HERE

TABLE 7 ABOUT HERE

Discussion

Do national assessments such as NAEP underestimate the reading achievement gap in the U.S., based on income inequality, since they only measure offline reading skills? The issue becomes more important as online reading becomes an increasingly important aspect of life and

as we experience growing income inequality in the U.S. (Congressional Budget Office, 2007), an increasing gap in reading achievement (Reardon, 2011; 2013; Bailey & Dynarski, 2011), and a decline in social mobility (Chetty, Hendren, Kline, & Saez, 2014). Having a portion of any society underprepared for literacy in an online age limits opportunities for both individuals and our nation.

Evaluating the Achievement Gap in Offline Reading Comprehension

Consistent with national results, data analysis in our sample found a large achievement gap in offline reading comprehension between seventh grade students attending an economically advantaged school and those attending an economically disadvantaged school. The achievement gap reported in our data is generally consistent with national data for offline reading achievement gaps (NCES, 2011a; 2013; Reardon, 2011).

These results indicate that the offline reading test scores of the seventh grade populations in these schools appeared to represent a reasonable sample with which to test for a separate online research and comprehension achievement gap. The differences between students in the two districts was large, significant, and matched reasonably well the differences found at the national level between students in economically advantaged and challenged school districts. Noticeably, though, the sample did not use the most extreme District Reference Groups and, thus, did not test the true extremes of economic circumstance between school districts.

Evaluating The Achievement Gap In Online Research and Comprehension

We also wanted to evaluate if income inequality was associated with online reading achievement. It was. Mean ORCA total scores were nearly twice as great for students attending West Town (15.00) as they were for students attending East Town (7.65), with a large effect size (Hedges $g = 1.47$).

The achievement gap in online reading was robust, appearing in mean comparisons of scores for students in the two districts for each of the four major skill areas, for each of the two research tasks, and for each of the four major skill areas in each of the two research tasks. (See Table 3.) Hedges g estimates for these comparisons ranged from .430 to 1.31, which are generally considered moderate to large effect sizes.

Evaluating a Separate and Independent Achievement Gap for Online Research and Comprehension

Currently, we define reading achievement gaps based on students' ability to read offline information (cf. NAEP, 2013). This study found an additional and separate achievement gap based on income inequality for online reading among students who completed both research tasks. A significant achievement gap in online research and comprehension persisted when differences in the most likely predictors of success in this area were conditioned for in the analyses: state reading achievement scores, prior knowledge, and state writing scores. After conditioning on all variables, students in East Town scored, on average, 2.7 (out of 32) points lower on online research and comprehension compared to students in West Town. The effect size associated with this difference was about 0.5 of a standard deviation. This separate and independent achievement gap for online reading appears to be an important one, and is just slightly less than the two-thirds of a standard deviation difference found on NAEP for offline reading. (NCES, 2011a.) If the separate effect size difference found in this study can be related to those on nationally normed assessments in reading reported by Hill, Bloom, Black, and Lipsey (2008), it appears to represent at least one additional year of annual growth at the middle school level beyond that reported for offline reading..

It has become common to interpret effect sizes in the social sciences using labels proposed

by Cohen (1988). Effect sizes of 0.20, 0.50 and 0.80 are considered "small", "medium," and "large" respectively. However, Cohen (1988) has stated that these suggestions were "...for use only when no better basis for estimating the effect size index is available" (p.25).

Hill, Bloom, Black, and Lipsey (2008) provide precisely this "better basis" for interpreting effect sizes related to educational achievement. Their work shows the annual reading growth in average test scores obtained across seven nationally-normed, vertically scaled tests. In effect size units the annual growth in the middle school years is between 0.12 and 0.44. Given that an entire year of schooling *and* other developmental growth that students experience in the middle school years results in an effect size no greater than 0.44, it seems fair to call effect sizes in the 0.3-0.5 range "large" in the context of educational achievement data.

Furthermore, Rutledge and Loh (2004), Breaugh, (2003) and others remind us that effect size estimates must be flexibly interpreted. Even a small effect size on an important issue such as mortality remains important and should not be ignored. One might argue that this is also the case for the results in this study. The results found in this study suggest that we currently underestimate reading achievement gaps in the U.S. by failing to include the reading demands required during online research and comprehension by at least an additional year of schooling.

The results of this study are important to consider in relation to the U.S. Department of Education's goal to close the achievement gap so that all students graduate from high school ready to succeed in college or careers (U. S. Department of Education, 2010). They suggest that an additional online reading achievement gap exists. Thus, the challenge in reading is substantially greater than we currently recognize and public policies also will need to change accordingly. The results are also important for other nations to evaluate within their own national contexts. As nations often seek to fulfill egalitarian principles through their educational systems,

an additional online reading achievement gap should be a concern for nations that profess these ideals (cf. Hatlevik & Gudmundsdottir, 2013). This is especially important since it appears likely that online research and comprehension will be an increasingly important part of our students' futures. Lack of opportunity in every nation is important to consider when the 85 richest people in the world have acquired as much wealth as the poorest half of the entire world's population (Credit Suisse, 2013).

Evaluating Data Loss

Concerned about the loss of data among students who only completed a single research task due to technology issues on the first day of testing, we evaluated the main question of interest with separate regression models for all students who completed either "Energy Drinks" or "Asthma." Three patterns from this analysis suggested that excluding these students from the primary analysis did not affect the results. First, even though the scale for the possible ORCA score in the secondary analyses (0-16) was only half that of the primary analyses (0-32), the percentage of variance accounted for by all variables in the single task models (44.2% for Energy Drinks and 46.3% for Asthma) was similar to that of the dual task model (53% for Energy Drinks and Asthma combined). Second, after conditioning for all variables, the mean difference scores for all students who completed Energy Drinks (1.6 out of 16) and Asthma (1.4 out of 16), when combined, matched closely the mean difference score for students who completed both Energy Drinks and Asthma (2.7 out of 32). In fact, it was slightly higher (3.0 compared to 2.7). Third, Hedges g estimates for these mean differences were all similar: for students who completed both Energy Drinks and Asthma, Hedges g = 0.54; for all students who completed only Energy Drinks, Hedges g = 0.52; for all students who completed only Asthma, Hedges g = 0.54. We concluded from these supplemental analyses that data loss did not substantially affect

the primary results.

Cautions

We urge some caution in interpreting the results of this study. First, this study used a convenience sample of two school districts in one state, selected carefully to ensure income differences between districts. While the results suggest that a separate and independent achievement gap exists in online research and comprehension based on income inequality, it is important to investigate this issue with larger populations and in more states. Currently, we are unable to do so since the National Assessment of Educational Progress does not include any skills related to online research and comprehension. This study suggests that it should, especially if the United States is committed to educational opportunity for all students in an online age of information.

In addition, it is important to note that this study used an economic indicator of school communities as a whole (e.g. DRG Group) to identify students, not an economic indicator for individuals (e.g., individual family income or individual eligibility for free and reduced price lunches). Previous work with offline reading achievement gaps (NCES, 2011a; Reardon, 2011) used economic indicators for individuals, which may have been more sensitive to any differences.

Third, the two districts selected in our convenience sample did not represent the most extreme economic levels of our national population. The state where our study took place is ranked within the top four states in relation to U.S. median family income (U.S. Census Bureau, 2012). In addition, our economically challenged district had a median family income of nearly $60,000 while the official poverty threshold in the continental U.S. is currently at $24,028 for a family of four (U.S. Census Bureau, 2013). This difference is not inconsiderable. In 2012, 21.8

percent of children under age 18 lived below the poverty line, nearly a quarter of the children in the United States (U.S. Census Bureau, 2012) Thus, our results are perhaps better construed as an exploration of the achievement gap between the privileged and the middle class and results may not be representative of gaps between children of upper class families and children living in poverty. It is likely that the gap observed in this study would have been even greater had we compared students from groups with more pronounced differences in income.

Student Performance Levels

Having noted these concerns, it may be useful to observe that students performed at a relatively low level during online research and comprehension tasks. West Town students were able to respond correctly about half of the time and East Town students were able to respond correctly about 25% of the time to ORCA items. If these levels characterize performance levels for online research and comprehension among students at other schools it should be a concern for both policy and instruction. The lowest areas of component performance appeared in Evaluation (M = 1.68 out of 8) and Communication (M = 2.15 out of 8). These two areas may be especially important to consider for instruction in schools.

The fact that students in both school districts did not perform at higher levels with online research and comprehension may be surprising to some who consider this generation to be "digital natives" (Prensky, 2001). Although today's students grow up in an online world and are developing skills in gaming, social networking, downloading video and audio, and texting, this does not mean that they are necessarily skilled in online information use. Indeed, research is showing how limited students' skills are in this area, including locating (Bilal, 2000; Guinee, Eagleton, & Hall, 2003; Kuiper & Volman, 2008) and critically evaluating information online (Walraven, Brand-Gruwel, & Boshuizen, 2008). Many students find it difficult to judge the

accuracy, reliability, and bias of information they encounter during online research (Bennett, Maton, & Kervin, 2008; Graham & Metaxas, 2003; Sanchez, Wiley, & Goldman, 2006; Wallace, Kupperman, Krajcik, & Soloway, 2000). In fact, adolescents tend to over generalize their ability to read online information effectively, informed by their ability to engage successfully with online social networking, texting, and video games (Kuiper, 2007). Previous research, and the results of this study, suggest that instruction in online research and comprehension is important to include in the literacy curriculum, especially if reading continues to shift from page to screen and online information use, inquiry, and problem based learning become increasingly important to learning (Author, 2013).

Interpreting These Results In Relation To Public Policies: Standards, Curriculum, And New Assessments

Online research and comprehension skills are just beginning to be recognized in the literacy curriculum in several nations including Australia (Australian Curriculum, Assessment and Reporting Authority, N.D.), Canada (Minister of Manitoba Education, Citizenship, and Youth, 2006), and the United States (CCSSI, 2012). An important design principle of the CCSS (CCSSI,2012) of the United States, for example, identifies these skills as a new and important component:

> "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.
> (p. 4)

Unfortunately, these online research and comprehension skills are never explicitly stated

in the CCSS anchor reading standards; the words “Internet” or “online” do not appear in any of the anchor standards for reading, though they do appear in one anchor standard for writing (Authors, 2012). It remains to be seen whether schools in the United States will recognize the changes taking place to reading and integrate the Internet and online research and comprehension skills into the literacy curriculum of their own accord when specific standards in reading do not expressly indicate to do this. Perhaps some will take advantage of the opportunity to revise up to 15% of the standards, and still remain a CCSS state (See Kendall, Ryan, Alpert, Richardson, & Schwols, 2012). They could, for example, alter CCSS in reading to more explicitly define an online reading context by including phases such as “on the Internet” or by including additional skills such as “critically evaluating the reliability of online sources.” Drew (2012) provides specific suggestions for doing so, making online research and comprehension skills more visible in the CCSS for reading.

It also remains to be seen whether items in the new assessments for the CCSS (2010) will adequately represent the nature of online research and comprehension. If they do, it is not yet clear if online research and comprehension will be combined in a single scale with offline reading or in a separate scale to more precisely chart the development of online research and comprehension skills. These issues are important to consider since economically challenged districts are often under the greatest pressure to raise test scores and may focus limited resources on instruction that maps precisely to standards and assessments in an attempt to increase student performance. If online research skills are not visible in either standards or assessments, economically challenged schools may be less likely to incorporate them into their curriculum.

This is not to say that this approach is desired; it is, though, a recognition of the realities that currently exist with such a heavy emphasis on testing in our classrooms (Vasquez Heilig &

Darling-Hammond, 2008). It is also a recognition of the potential consequences that may result from decisions about what and how to evaluate students with high stakes assessments. The potential exists for standards and assessments to increase, rather than decrease, the achievement gap in online research and comprehension as suggested by the results of this study. Economically challenged, and often lower performing, schools may be more likely to focus on the explicit formulation of reading standards and fail to include their meaning within an online context.

This may have happened in the schools used in this study though there is only tentative evidence to suggest this possibility. Students in the two districts reported a significant difference in response to the question, "How often have you been required to use the Internet for a school assignment?" Only 4% of students in West Town responded that they had never been required to use the Internet at school while 25% of students in East Town indicated that they had never been required to use the Internet at school even though East Town had a better ratio of students to instructional computers at the middle school with Internet access (3.3) compared to West Town (3.7). Notably, none of the state standards for these schools, in place during the study, included reading in online contexts.

While these data only show correlation, not causation, it would be ironic, indeed, if national standards and assessments, designed to close achievement gaps, end up increasing the achievement gap in online research and comprehension because they fail to adequately represent the new social practices, skills, and strategies important to reading in an online age. Of course, an alternative future is also possible, one in which we prepare students for the new social practices, skills, and strategies of online reading and learning, creating a future in which new insights, new ideas, and new futures are made possible by teachers who thoughtfully integrate online research

and comprehension into the literacy curriculum.

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Table 1

Economic and Technology Indicators for West Town and East Town School Districts

Economic Indicator	West Town	East Town
Median Family Income	$119,228	$58,981
Percentage of Families Below the Poverty Line	2.1%	11.8%
Percentage of Students Eligible for Free/Reduced Price Lunches	4%	67%
No. of students per instructional computer at the middle school	3.7	3.3
% of computers with Internet access at the middle school	100	100
% of computers with high or moderate power at the middle school	100	100

Table 2

The Skill Areas for Online Research and Comprehension Evaluated in Each LESC Scenario

Reading to Locate Online Information
1. On the first search task did the student use appropriate keywords, entering both topic and claim as search terms?
2. For the first search task, did the student read, infer, and select a correct site from search results on the first click?
3. For the second search task, did the student read, infer, and select a correct site from the search results on the first click?
4. Did the student correctly identify both website addresses from the two search tasks?

Reading to Evaluate Online Information
1. Was the student able to correctly identify the author/creator of the focal website?
2. Was the student able to provide an accurate detail about the author's level of expertise?
3. Was the student able to provide accurate information about the effectiveness of the author's use of evidence for arguments?
4. Was the student able to provide a reasonable evaluation and logical explanation of the focal website's reliability?
Reading to Synthesize Information
1. In their first summary of what they learned, did students include two details in their own words from the first website?
2. In their second summary of what they learned, did students show evidence of intertextual information use, integrating information across the first two websites?
3. In their third summary of what they learned, did students show evidence of intertextual information use, integrating information across the first two websites?
4. In their argument, did they include a claim with evidence using two relevant details?
Reading and Writing to Communicate Information
1. Were students able to use the communication tool (email or wiki) to post or send a message with an appropriate heading or subject?
2. Were students able to communicate in a way that demonstrated awareness of audience?
3. Did students use any visual elements to make meaning clearer?
4. Did students craft an explicit, unambiguous, response to the question?

Table 3

*Means***, Ns, SDs, and Hedge's g Values for the Evaluation of Achievement Gap Differences: Offline Reading, and Online Research and Comprehension*

	West Town Mean	East Town Mean	Hedge's g
Offline Reading: State reading scaled score	282.60 (41.54)	215.10 (31.07)	1.87
Online Research and Comprehension: ORCA total score (out of 32)	15.00 (5.69)	7.65 (4.39)	1.47
Locate Total (out of 8)	4.47 (2.29)	2.41 (1.86)	1.00
Evaluate Total (out of 8)	2.26 (1.32)	1.26 (.93)	.897
Synthesize Total (out of 8)	5.15 (2.03)	2.58 (1.89)	1.31
Communicate Total (out of 8)	3.13 (1.55)	1.43 (1.11)	1.29
Energy Drinks Total	6.91 (3.16)	4.05 (2.64)	.993
Locate	2.02 (1.32)	1.30 (1.20)	.573
Evaluate	1.02 (.809)	.716 (.618)	.430
Synthesize	2.37 (1.33)	1.37 (1.29)	.763
Communicate	1.51 (1.05)	.70 (.68)	.944
Asthma Total	8.09 (3.25)	3.59 (2.38)	1.61
Locate	2.45 (1.36)	1.11 (1.08)	1.11
Evaluate	1.24 (.88)	.541 (.564)	.976
Synthesize	2.78 (1.25)	1.21 (1.17)	1.30
Communicate	1.62 (1.04)	.737 (.713)	1.02

Notes. $N = 103$ (West Town) and 105 (East Town) for Offline Reading tests and 108 (West Town) and 148 (East Town) for all Online Reading tests.

***$p \leq .0001$ for all means tests. All means tests were also significantly different when a Bonferroni correction was used.

Table 4

Means, Standard Deviations, and Intercorrelations Among School District, State Reading Scores, Prior Knowledge Scores, and State Writing Scores

Dependent and Independent Variables	1	2	3	4	5
1. School District	--	-.682***	-.117**	-.617***	-.605***
2. State Reading Scores		--	.108**	.774***	.697***
3. Prior Knowledge Scores			--	.104	.029
4. State Writing Scores				--	.624***
5. Total LESC Score					--
M	.570	244.31	4.71	252.35	11.08
SD	.497	49.11	4.13	41.72	6.09

N = 238 across all variables. ***p* < .05. ****p* ≤ .0001.

Table 5

Regression Analysis of School District, State Reading Scores, Prior Knowledge Scores, and State Writing Scores on Total ORCA Scores for Students with Two Complete LESCs, Energy Drinks for All Students Who Completed This LESC, and Asthma for All Students Who Completed This LESC

Dependent and independent variables	*Total ORCA b*	*Energy Drinks b*	*Asthma b*
Total ORCA Scores			
School District	-2.70**	-1.6**	-1.39**
State Reading Scores	.053**	.024**	.005**
Prior Knowledge Scores	-.089	-.034	.009
State Writing Scores	.024*	.017*	.018**
R^2	.530	.442	.463
F	65.82**	54.80**	56.204**
n	238	290	303

Note. **p* < .05. *** p* ≤ .001.
b = unstandardized.

Table 6

Responses to the survey question: "How many computers are in your home that are connected to the Internet?"

	0	1	2	3 or more	Total
West Town Students	1 (1%)	15 (15%)	23 (23%)	62 (61%)	101 (100%)
East Town Students	12	45	39	48	144

Note. Chi-square = 23.392. df = 3. p = .0003

Table 7

Responses to the Survey Question: "How Often Have You Been Required to Use the Internet at School?"

	Never	Once a week or less	More often than once a week	Total
West Town Students	4 (4%)	52 (52%)	44 (44%)	100 (100%)
East Town Students	35 (25%)	55 (39%)	52 (37%)	142 (100%)

Note. Chi-square = 18.665. df = 2. *p* = .0005

Figure 1. An example of the social network context for the assessment, Energy Drinks, an email communication task. These images contain the sequential messages from the avatar student, guiding each student through the research task. Here, the avatar directs the student to the initial email message, defining the nature of the research request from the School Board President.