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Abstract

This quantitative study was developed to explore the ability to impact elementary student 21st Century online research skills with a planned classroom intervention curriculum. The repeated measures quasi-experimental study randomly assigned all 5th grade classes in a Midwestern, suburban school (n=418) to a 12-week intervention or control condition. Analyses of the ORCA Elementary-Revised performance prior to intervention revealed significant correlations with traditional measures of reading achievement as well as limited influence from demographic variables. In the primary research question, results demonstrated that the intervention group showed significantly higher gains from pretest to posttest on the measure of online research skills. Focused analyses of the subskills in the online reading performance measure revealed these differences were durable in locating and synthesizing skills, but not critical evaluation of websites. We discuss both theoretical and instructional implications generated from this study.



Successfully Promoting 21st Century Online Research Skills: Interventions in 5th-Grade Classrooms

The 21st Century skills and strategies needed to read and do research online are multifaceted, and require sophisticated and complex application in online environments (Afflerbach & Cho, 2009; Leu, Kinzer, Coiro, Castek, & Henry, 2013). Informational communication technologies present additional complexities because they are deictic, or continually changing, and require teachers to reassess what it even means to be literate (Leu, 2000, p. 745). Despite the fact that online literacy skills are deictic, our educational systems are slow to change practice to meet the needs of today's learners. In fact, few studies exist on the effects of teaching online research skills in classroom settings.

Twenty-first Century literacy skills were not “invented” with the Internet; competent readers use many of the same offline text strategies as those they use with online texts (Coiro & Dobler, 2007). However, digital literacy has made the standards for literacy broader, often requiring higher levels of thinking and problem solving skills than are associated with traditional print (Castek, 2008; Coiro, 2009; Eagleton & Guinee, 2002; Kuiper, Volman, & Terwel, 2008). With online texts, students need new sources of prior knowledge, higher levels of inferential reasoning, and advanced, self-regulated, navigation strategies (Afflerbach & Cho, 2009; Coiro & Dobler, 2007). The complex space of the Internet requires flexible and strategic application of skills that enable readers to negotiate the constantly changing landscape of a hypertext reading environment (Cho, 2014). Internet-based reading requires learners to use self-regulatory strategies that include locating, critically evaluating, and synthesizing information from a multiplicity of sources, a complex process including monitoring and self-explanation when done by better learners (Goldman, 2012; Goldman, Braasch, Wiley, Graesser, & Brodowinska, 2012). This process has been termed “realizing and processing potential texts” by Cho and Afflerbach (2015, p. 500) because of the many choices readers must make in hyperlinked environments, the metacognitive strategies they must enact, and the texts that are constructed as a results of

these strategic decisions and actions.

Readers who struggle with offline texts show these same patterns with online texts where the strategic and flexible application of strategies for constructing intertextual meaning is required. In online contexts, less skilled readers showed greater difficulty in appropriately and effectively applying strategies needed for comprehension, searching for task-relevant information and images, determining the relevance of information, making decisions about the credibility of information, and acting on those decisions (Chen, 2009; Cho, 2014; Dee-Lucas, 1999; Goldman, Braasch, et al., 2012; Lawless & Kulikowich, 1996; Pei-Lan, Lin, & Chuen-Tsai, 2013; Wilder & Dressman, 2006).

Curriculum reform initiatives are also changing the shape and nature of 21st century learning and assessment. The Common Core State Standards (CCSS), a noteworthy educational reform, showcases an increased focus on literacy, information and communication technologies, and the use of increasingly complex expository text, including Internet text (National Governors Association Center for Best Practices [NGA Center] & The Council of Chief State School Officers [CCSSO], 2010). In fact, the CCSS calls for expository text to account for 50% of total instruction by fourth grade, recognizing that most of our knowledge base as adults stems from informational text. Neglecting the use of expository, Internet-based text in classrooms is a cause for concern, which is perpetuated simultaneously by the limiting view that technology is merely a supplement to the curriculum, teachers' inexperience in incorporating authentic online materials in their lessons, and insufficient classroom curriculum materials that direct learning through online resources (Dreher & Zelinke, 2010; Hutchison & Reinking, 2011).

21st Century Online Research Skills

This study builds upon the need to teach 21st Century literacy skills to upper elementary readers. We centered our study on the following three subskills necessary to conduct 21st century online research: 1) locating information, 2) evaluating information, and 3) synthesizing information. We strengthen the rationale for 21st Century online research skills with relevant literature and perspectives that justify instruction in each of the three subskills.

Locating Information

Locating, or searching for information, has been noted as a “gatekeeper” skill (Henry, 2006) and is a fundamental component of online research. Students, however, often approach the Internet with a “snatch and grab” philosophy (Sutherland-Smith, 2002, p. 664) with the expectation of finding information quickly and often preferring to seek information through browsing rather than strategic searching (Schacter, Chung, & Dorr, 1998). Kuiper and her colleagues (2008) characterized 5th grade students as impulsive Internet searchers who tend to get lost in the searching process. While the results of another study (Rouet, Ros, Goumi, Macedo-Rouet, & Dinet, 2011) determined that young students had difficulties using relevant cues to select appropriate Internet sites. Seventy-six percent of teachers in a survey by Pew indicated they believed that middle and high-school students expect to be successful finding information quickly and easily with search engines (Purcell et al., 2012); yet, children and teenagers have trouble narrowing the search terms and self-regulating the search process (Pritchard & Cartwright, 2004; Quintana & Pujol, 2010), often becoming easily distracted, frustrated, or anxious when searching for information (Colwell, Hunt-Barron, & Reinking, 2013; Hill & Hannafin, 1999).

Central to locating information is the ability to generate questions when working in online environments (Leu, Forzani, et al., 2013) because online research regularly begins with a question to ask or problem to solve (Leu, Zawilinski, et al., 2007). In fact, students who self-generate research questions in online environments have increased motivation and increased success in the searching process (Dwyer, 2010; Kuiper et al., 2008). The need to embed questioning instruction within the teaching of locating information is indubitable as students typically begin research without formulating a question (Eagleton & Dobler, 2007).

Critically Evaluating Information

Since the Internet is an unfiltered environment, allowing anyone to publish information at will critical evaluation is a central requirement for effective online research (Leu, Kinzer, et al., 2013). Past research has confirmed that higher order thinking and critical evaluation skills are difficult processes for intermediate-grade students (Castek, 2008; Chen, 2009; Kuiper, 2007; Kuiper et al., 2008), and teachers recognize students struggle with this

concept. Only 1% of middle and high school teachers considered students as highly skilled at determining bias in Internet content, yet teachers believe that judging the quality of information found on the Internet is essential (Purcell et al., 2012). Students typically do not take a critical stance towards Internet-based text; furthermore, they consider the Internet the most credible source of information, over and above books (Kiili, Laurinen, & Marttunen, 2008; Kuiper, Volman, & Terwel, 2005; MacArthur Foundation, 2010). Research-tested frameworks, such as the WWWDOT examining: 1) **W**ho wrote this?, 2) **W**hy was it written?, 3) **W**hen was it written?, 4) **D**oes it help meet my needs?, **O**rganization of the site?, and 5) **T**o-do list for the future (Zhang & Duke, 2011) showed students receiving instruction within the framework demonstrated improved web evaluation skills and attentiveness to the necessity of evaluating online text. Students need to be taught specifically how to critically evaluate Internet-based text, think critically, and question content before assuming it is trustworthy information.

Synthesizing Information

A third subskill, synthesizing information found on the Internet, is also a difficult feat for students who must continuously evaluate and summarize across multiple Internet sites (Coiro & Dobler, 2007; Eagleton, Guinee, & Langlais, 2003; Kuiper et al., 2005). Furthermore, synthesis is an internal process, which makes this online research skill possibly the most difficult to examine and measure (Leu, Zawilinski, et al., 2007). Past studies have examined the effect of synthesis instruction and summarizing instruction with online text, noting students who received direct instruction on synthesis improved performance on this subskill (Castek, 2008). Conversely, Dwyer (2010) found that students, in general, struggle to summarize Internet information, even after instruction and practice. Goldman and her colleagues' work with multiple source comprehension found the majority of students in grades five through eight (77%) could be categorized as "selectors" who produced essays primarily by blocking or selecting information sequentially from each text, without revising or synthesizing inferences (Goldman, Lawless, et al., 2012, p. 200). This "copy-delete" strategy (Dwyer, 2010) not only exists with Internet-based text, but traditional text as well (Hidi & Anderson, 1986). Internet text can make copying information effortless (Eagleton & Dobler, 2007). Limited teacher knowledge in assisting students with the demands of text synthesis is troublesome, as future assessments will be representative of this skill (Goldman,

Lawless, et al., 2012).

Internet Reciprocal Teaching Model

The Internet Reciprocal Teaching (IRT) Model, selected as the instructional framework for this study, stands as an effective model for promoting online research skills for adolescents (Leu et al., 2005; Leu & Reinking, 2010) and elementary students (Castek, 2008). IRT is based on the well-established and widely used Reciprocal Teaching (RT) Model (Palincsar & Brown, 1984), which promotes strategies for reading comprehension using printed text. Within their meta-analysis of 16 quantitative RT studies, Rosenshine and Meister (1994), found RT to have a consistent and substantial effect size (.86) when implementing comprehension assessments in intervention settings. This indicates RT as a favorable method for reading strategy instruction.

The adjustment of the standard print-literacy RT practices to develop the IRT model was designed explicitly to support reading comprehension in online environments. Core values within both models center on instructional scaffolding within the Zone of Proximal Development (ZPD) which is the developmental range of achievement between what the learner has mastered independently and what the learner can do with adult or peer assistance (Vygotsky, 1978, p. 86). The give-and-take between teachers and students produces a scaffolding support system. The balance between modeling, instruction, and guided practice provides the learners the experiences needed to independently implement comprehension strategies with text (Palincsar & Brown, 1986).

Additionally, both models support the use of metacognitive strategies to self-regulate learning. Metacognition is commonly defined as *thinking about one's thinking*. Through a gradual release of responsibility, the practice of RT supports the learner in applying taught comprehension strategies in new reading contexts (Brown & Palincsar, 1989). When considering Internet-based texts, additional meta-cognitive strategies to navigate online texts are required by strategic readers—requiring the reader to flexibly integrate active self-regulated reading strategies (Cho & Afflerbach, 2015; Coiro, Castek, Henry, & Malloy, 2007).

Differences between RT and IRT certainly include a shift in texts (print to online), narrowing of text genre (solely expository with text determined by

the individual's learning path), and strategy skills. Another notable difference between RT and IRT is the shift in grouping. RT typically occurs in small groups, where the teacher first models before having students model strategy use to each other. IRT, on the other hand, occurs within a self-contained classroom and with a larger number of students (Leu et al., 2008).

Although both RT and IRT provide a gradual release of responsibility, IRT places this gradual release within a 3 phrase model where tasks progress from simple to more complex. The teacher first models online research strategies as a whole group (phase 1) followed by students collaborating to practice strategies within partners or small groups, preferably with 1:1 computing devices, and centered around common tasks (phase 2). Lastly (phase 3), students engage in an independent inquiry to apply knowledge of the online research skills to authentic learning situations. As learning progresses, students choose an inquiry topic of interest, often relating to existing curriculum, to practice strategies during online research tasks. Table 1 presents a thumbnail sketch comparison between RT and IRT strategy instruction as presented by Leu (2008).

Previous research with IRT has shown this model effective with supporting struggling traditional readers (Castek, Zawilinski, McVerry, O'Byrne, & Leu, 2011; Henry, Castek, O'Byrne, & Zawilinski, 2012; Leu et al., 2008). Leu & Reinking (2010) found IRT significantly increased online reading comprehension with middle grade learners when compared to students in control classrooms. Additionally, IRT instruction with online text has been demonstrated to promote positive results regarding peer collaboration as students shift to the role of the "expert"—taking control of their learning (Castek, 2008; Henry et al., 2012). Colwell and his colleagues (2013) investigated IRT as a means to developing digital literacy in middle school science instruction with 16 consecutive, weekly lessons. Lessons embedded digital literacy skills within student inquiry projects and found that open-ended inquiry projects with moderate structure provided the best context for practicing strategies related to locating and evaluating Internet-based text; however, the students in their study struggled to internalize strategies, often abandoning these strategies when working independently.

Purpose of the Study

The impetus for this research study was prompted by the confluence of

Table 1. Comparison between Reciprocal Teaching (RT) and Internet Reciprocal Teaching (IRT)

	RT	IRT
Strategies	<ul style="list-style-type: none"> • Predictiong • Questioning • Clarifying • Summarizing 	<ul style="list-style-type: none"> • Generating Questions • Locating Information • Evaluating Sources • Synthesizing Information • Communicating Information to Others (e.g. blogs or e-mail)
Setting	Small Groups	1:1 Laptops
Modeling	Emphasis on teacher modeling reading comprehension strategies	Emphasis on teacher modeling and peer modeling of comprehension strategies with online text
Gradual Release of Responsibility	Teacher scaffolds students through continued practice to develop a range of self-regulated metacognitive strategies	Instructional scheme occurs within three distinct phases, scaffolding students from direct instruction to independent inquiry.

several factors in education and educational research. First, there is an increase in the use of Internet-based expository texts in schools due to the guidelines driven by the CCSS, which naturally heightens the need to build greater instructional support for teachers using expository text (NGA & CCSO, 2010) . Second, research has illustrated that students need to develop more sophisticated online research strategies to be successful in constructing meaning with Internet-based text (Cho & Afflerbach, 2015; Coiro, 2011; Coiro & Dobler, 2007; Leu & Reinking, 2010). Third, while efficacy outcomes within IRT have been mixed, in general, three factors (teacher modeling, systematic instruction, collaborative work) appear to be important to the successful translation of the strategy training to successful online research.

This study was designed to continue to refine our understanding of 21st

Century online research skills for children in traditional classroom settings. Our first research question was: Which variables best predict performance (prior to program instruction) on 21st Century online research skills assessment for all learners? This question was centered on identifying the relationships among traditional and online reading assessments, as well as individual differences among the learners as sources of variance. The second research question was: Do students in classes where teachers use scripted lessons focused on promoting 21st century online research skills show significantly greater gains than a randomly assigned comparison sample in locating, evaluating, and synthesizing online content over the course of an academic semester.

Methods

Overview

This quasi-experimental research study was developed to (a) identify effective predictors of 21st Century online research skills for students in standard 5th grade classrooms and (b) test the impact of scripted instructional materials on student outcomes in a standard intermediate school over a 12-week period. To identify predictors for the 21st Century online research skills, regression analyses predicting performance of all 5th grade students on a pretest were conducted. To test the effect of the intervention, teachers were randomly assigned to the treatment or comparison conditions (see following section on instructional activities for more details). The 12 weeks involved two weeks of pretesting for all participants, eight consecutive weeks of intervention for the treatment group (which consisted of classroom teachers providing scripted lessons in 21st Century online research) and two weeks of posttesting for all participants. Over the course of the intervention, teachers in the treatment condition delivered 13 lessons focused on improving 21st Century online research skills (approximately 10 instructional hours) while control group teachers maintained their standard instructional practices.

Participants

Participants in this study were 418 fifth grade students (48% boys, 52% girls) from a suburban intermediate school that serves students in grades five and six (total of 1,015 students, average class size of 27 students). At this school, there were 12 teachers who instructed fifth-grade language arts classes (average of nine years teaching experience, over half holding a masters degree in elementary education). Collectively, the 12 teachers instructed 19 sections of

Language Arts courses (five of which were identified as advanced classes). All 12 teachers volunteered to participate in the study with the understanding that assignment to the experimental and comparison conditions would be handled through stratified random selection (Gall, Gall, & Borg, 2005) to ensure that there was reasonable distribution of the five Advanced Language Arts sections to the two conditions. This was accomplished by first randomly assigning two sections of Advanced Language Arts to each condition. The remaining Advanced Language Arts class and all regular sections in the school were subsequently assigned to the control or experimental group through randomized cluster sampling conducted at the teacher level. That is, assignment to condition was confined to the teacher level to ensure that each teacher taught only one condition (for those teachers with two sections of Language Arts classes). The end result was ten Language Arts classes in the experimental group (5 teachers, 218 students) and nine Language Arts classes in the control group (7 teachers, 200 students), with two out of the five advanced Language Arts classes participating in the experimental group.

School records indicated 16% percent of students participating in the study received free and reduced lunch. Demographic data showed 74% of participants were White, 8% Black, 2% Hispanic, 8% Asian/Pacific, 7% Multiracial, and less than 1% American Indian. Comparisons between the treatment and control groups demonstrated equitable distribution of gender, ethnicity, and socioeconomic status across the two conditions. Although all fifth grade students participated in the instructional activities consistent with their teachers' randomly assigned condition, students identified with special needs were excluded from the current analyses to limit the impact of confounding effects imposed by individualized instructional interventions.

Measures

Several performance-based assessments of reading comprehension and research in open, networked environments have previously been developed (Castek, 2008; Coiro, 2011; Leu et al., 2005; Leu & Reinking, 2010; New Literacies Research Team, 2005) with additional assessments being developed by the Online Research and Comprehension Assessment (ORCA) Project to assess online research (Leu, Kulikowich, Sedransk, & Coiro, 2009). Models have been created to help educators understand and assess multiple-source comprehension (Goldman, Braasch, et al., 2012; Goldman, Lawless, et al.,

2012). ORCA performance-based measures including ORCA-Blog, ORCA-Instant Message (New Literacies Research Team, 2005), ORCA-Iditarod (Leu et al., 2005), ORCA Scenarios I and II (Coiro, 2011), and the ORCA-Elementary (Castek, 2008) take students through a series of online information tasks incorporating a variety of Internet resources. Rubrics for each Internet task evaluate students on their ability to search, locate, evaluate, synthesize, and communicate information.

21st Century online research performance. For this study, an adapted version of the ORCA-Elementary was used to measure 21st Century online research skills. The ORCA-Elementary assesses online research skills with 4th and 5th grade students through five tasks (i.e., ask questions, search, critically evaluate, synthesize, and communicate information) posed as informational problems (Castek, 2008). Validation for the ORCA-Elementary was established through iterative reviews with expert review panels, a participating teacher, and the original author (Castek, 2008) and found to be valid and reliable (Cronbach's Alpha = .79) for that initial study with a single classroom.

To enable a school-wide implementation, we modified the ORCA-Elementary to fit within a 60-minute time frame. In the end, the ORCA Elementary-Revised used in this study included four tasks that measured three discrete subskills (locate, evaluate, synthesize; see <http://tinyurl.com/ORCAELEM-REVISED> to access the full assessment). This revision to the ORCA-Elementary also allowed for more consistent scoring as we prescribed the content of the online research activities within a secure web-based assessment environment.

Student responses were analyzed and scored by the first author, who was blind to participant condition, according to the ORCA Elementary-Revised rubrics to evaluate performance of 21st Century online research skills (see: <http://tinyurl.com/ORCAELEM-REVISED-RUBRICS>). Reliability of the coding process was determined through a 10% validation check conducted with a second coder who was an elementary school teacher with a Master's degree and ten years teaching experience. Review of the independent codes for the primary and second coding demonstrated a high degree of consistency across the two ratings ($r = .94$). Questions for this assessment measure were categorized within three subskills, including locating information, synthesis, and evaluation, which were equally weighted. A sample of student open-ended

responses for each subskill coded according to the assessment rubric can be found in Tables 2-4. Assessment criteria for each subskill are included below.

1. *Locating Information:* Participants generated and revised questions to begin the query process. Tasks 1-3 required students to locate a specific website based on a description posed by fictitious students in the question stem. Partial credit was awarded to students who found similar sites or listed the site's URL through the domain name (i.e. news.bbs.co.uk). To earn full credit, students needed to correctly post the full URL for the requested website (i.e. news.bbc.co.uk/cbbcnews/hi/static/guides/animals). Locating additionally involved students answering question prompts using information posted within the correct website. Only partial credit was awarded to students who answered question stems using related prior knowledge or information posted on a similar website. Within task 4, direct links were instead provided, as used in previous online measures (Castek, 2008; Coiro, 2011), to eliminate the need to first locate the required information before synthesizing and evaluating content.
2. *Evaluating Information.* Within tasks 2-4, students employed critical evaluation skills to explain reliability of information. Tasks involved evaluating the author's credentials (*Are the maker's experts? How do you know?*), verifying content with additional websites, and determining which, if any, websites were deceptive or unreliable by listing specifics from the website to justify their conclusions. Full credit for evaluation tasks were awarded to students who provided justification for the author's/website's credibility based on something learned through exploration of the website or implementation of a strategy to verify content (i.e. *I googled it and learned it was a hoax*).
3. *Synthesizing Information.* Students synthesized within and across websites on the ORCA Elementary-Revised. In task 1, students explored a website's animated interactive before providing information as to why animals become endangered. Responses needed to include reasons presented from multiple pages within

the interactive. The fourth task on the ORCA Elementary-Revised required students to explore three similar sites on a related topic, dog friendly vacations. After viewing all three sites, students were asked to synthesize across the websites by providing specific examples as to how these locations would work to keep dogs safe. To earn full credit on this task, students had to collect and provide information from more than one site in their

Table 2. Sample of Student Open-Ended Responses for Locating Subskill Coded According to the ORCA-Elementary Revised Rubric

Task Question: Locate number of otter species and locate a second site where this information could be verified.		
Score	Rubric Criteria	Sample Student Response
0	<i>Task not successfully completed.</i> No answer is given for this part of the question or “I didn’t find it,” or didn’t give a URL at all.	www.sea interactive.com
1	<i>Too general.</i> Located a webpage related to sea otters but it was NOT made by correct organization. They must give a URL in to order to get credit.	animals.nationalgeographic.com/ animals/mammals/sea-otter/
2	<i>Partially correct.</i> Found the information about sea otters on the correct organization, but did not locate the interactive.	www.montereybayaquarium.org/...otter/otter_resources.aspx
3	<i>Task successfully completed.</i> Located the Sea Otter Interactive with in the correct organization and gave the correct URL.	http:// www.montereybayaquarium.org/ media/all_about_otters /whatsanotter01.html

response.

Traditional reading achievement. To measure reading achievement through traditional approaches, scores from two standardized assessments were collected from school records. First, the statewide English/Language Arts

Table 3. Sample of Student Open-Ended Responses for Synthesizing Subskill Coded According to the ORCA-Elementary Revised Rubric

Task Question: What are some ways these places will make sure my dog is safe?		
Score	Rubric Criteria	Sample Student Response
0	Task not successfully completed. No answer was given for this part of the question OR response does not answer the question correctly by providing a way dogs can stay safe.	It sounds safe.
1	Response wasn't based on the results of a synthesis from the websites. Students talked about ways dogs can be safe on vacation from their own prior knowledge.	They will make sure that there are good people there who like dogs.
2	Partially correct. Student collected information on ways dogs can stay safe but only included ideas from one of the websites.	Have the dogs and you wear a life jacket, and always have an experienced boater in the canoe.
3	Response was correct and complete. Student collected information from more than one site and provided at least two ways dogs could be kept safe based on information from given websites.	Even though your dog is off it's leash, Dog Paddling Adventures will make sure your dog is in a close distance. All dogs will be seen. If needed, you can put your dog on a leash for the hikes. Camp Winnaribbun does the same thing. These places are most reliable and I think your dogs will have fun at these resorts.

(ELA) proficiency test (State of Indiana Department of Education, 2010) was gathered. The ELA measures a collection of literacy skills including vocabulary, reading comprehension, and writing applications for grades three through ten. Analyses of the ELA conducted by the Department of Education demonstrated reasonable reliability (with internal consistency estimates across grade levels reported at Cronbachs alpha = .91) and construct validity established through confirmatory factor analysis (State of Indiana Department of Education, 2012).

Table 4. Sample of Student Open-Ended Responses for Evaluating Subskill Coded According to the ORCA-Elementary Revised Rubric

Task Question: What are some ways these places will make sure my dog is safe?		
Score	Rubric Criteria	Sample Student Response
0	Task not successfully completed. No answer is given for this part of the question. Misunderstood question: response did not state or explain reasons why the sites were real or not. Incorrect Answer: Student explained reasons why Dog Island is a real place. May also mention the other(s).	They [dog island] have two different sides one for huge dogs and one for small dogs and meg med dogs. Each dog is given a Dog Island Dog Tag, which allows us to know by use of GPS where he or she is at all times. They
1	Partially correct. Student implied the sites were real/fake but reasoning wasn't based on any info. They addressed (i.e. they drew a conclusion but did not provide ANY evidence as to why they felt that way). Mentioned a strategy for how they could check whether it was false or not.	They will make sure that there are good people there who like dogs
2	Correct but incomplete. Student reasoned that the sites were real./fake prior knowledge (domestic dogs can't live without people, dogs don't behave that way, etc.)	Because dog island's FAQ didn't seem serious
3	Task successfully completed. Provided a logical a reason based on learning something about the author and/or the information or the author's contact information. Ask for references, etc. (ex: I googled it and learned it was a hoax, the authors made the site look real, but they are playing a trick to make people laugh, etc.) Mentioned a strategy for how they could check whether it was false or not.	I know because dog island has a disclaimer saying it is not real.

The second traditional reading assessment used in this study was the Scholastic Reading Inventory (SRI), a computer adaptive reading assessment program that measures reading comprehension using the Lexile Framework® for Reading (Scholastic Inc., 1999). As students are presented with questions,

the questions progressively increase or decrease in difficulty until the student's reading ability has been determined. Scholastic (2007) provides extensive documentation in its technical manual demonstrating scale reliability and validity procedures used during the creation of the SRI using Research modeling techniques. In addition, repeated third party objective confirmations of the scale have demonstrated criterion and construct validity that demonstrates significant correspondence to learning gains over time and reading proficiency development effectively captured with the SRI adaptive testing procedure (e.g. Hewes, Mielke, & Johnson, 2006, January; Pearson & White, 2004, June; Williamson, Thompson, & Baker, 2006, March).

Treatment Condition: Online Research Instructional Activities

We developed a stand-alone 21st Century online research unit that included 13 scripted lessons complete with lesson plans, supporting PowerPoint materials, learning modules, interactive materials for students, and video tutorials for the teachers. The teachers assigned to the experimental group attended an overview meeting of IRT and the provided curriculum. These teachers then agreed to deliver the 13 lessons over an 8-week period using a combination of one computer lab with 30 computers and a mobile pod of 25 laptops with wireless connectivity that were used in the classrooms. This setup allowed each student to have independent and equal access to computers during the instructional period of the study. Teachers also had access to Liquid Crystal Display (LCD) projectors where online information as well as presentation documents was projected onto a classroom screen for all students to view.

The lessons created for this study provided explicit instruction on the three 21st Century online research skills (locating, evaluating, synthesis) employing an instructional process consistent with IRT as previously described in this paper. As shown in Table 5, for each 21st Century online research skill, all three phases of IRT (teacher modeling, guided practice, independent inquiry) were addressed during at least one lesson. The lessons were representative of the skills measured within the assessment (ORCA Elementary-Revised) and anchored within the school's standard-based curriculum; however, there was no overlap in content between the topics in the assessments and the topics in the IRT lesson or student inquiry projects. Lessons within each skill progressed from simple to more complex Internet tasks, allowing students to build greater competence before engaging in the final IRT phase (independent inquiry). For

example, critical evaluation lessons seven through ten incorporated teacher modeling and guided practice in preparation of students completing their own critical evaluation of online text during independent inquiry (see Table 5; lesson 11). In the following sections, we provide description snapshots of the curriculum arranged by each of the assessed skills

Locating information. The first lesson, titled “Nuts & Bolts,” began by teaching students the basic skills needed to effectively locate information and understand the tools available to support researching in online environments.

Table 5. *Timeline of Online Reading Comprehension Sessions*

Session	Skill/Lesson	IRT ^a Phase ^b		
1	Basic Skills <i>Nuts & Bolts</i>	Phase 1	Phase 2	Phase 3
2	Questioning/Locating <i>What is Your Question</i>	Phase 1	Phase 2	Phase 3
3	Locating <i>Key It In</i>	Phase 1	Phase 2	Phase 3
4	Locating <i>Search Box Strategy</i>	Phase 1	Phase 2	Phase 3
5-6	Locating <i>Inquiry Searching</i>	Phase 1	Phase 2	Phase 3
7	Critical Evaluation <i>Who is the Author?</i>	Phase 1	Phase 2	Phase 3
8	Critical Evaluation <i>Is it Accurate?</i>	Phase 1	Phase 2	Phase 3
9	Critical Evaluation <i>Cite the Copyright!</i>	Phase 1	Phase 2	Phase 3
10	Critical Evaluation <i>Bias, It's Everywhere</i>	Phase 1	Phase 2	Phase 3
11	Critical Evaluation <i>Evaluation Wizard</i>	Phase 1	Phase 2	Phase 3
12	Synthesis <i>Synthesizing Information?</i>	Phase 1	Phase 2	Phase 3
13	Synthesis <i>Synthesis Response</i>	Phase 1	Phase 2	Phase 3

^aInternet Reciprocal Teaching

^b**Phase 1:** Teacher Modeling; **Phase 2:** Guided Practice; **Phase 3:** Independent Inquiry

Students engaged in lessons on how to open and navigate within websites, discover shortcuts, utilize online tools such as edit-find, learn Internet-specific vocabulary, troubleshoot problems, and understand the basic layout of an Internet page. We developed short video tutorials to showcase these skills (teacher-led demonstration) followed by guided partner practice and discussion. For example, after a demonstration of the difference between a domain and universal resource locator (URL) using a website relevant to student interests (i.e. espn.go.com), students divided up the components of a URL and examined the purpose of a domain name (.com, .edu, .gov, etc). Guided practice afforded students the opportunity to examine the effect of a domain suffix after a given name (i.e. www.indiana.edu versus www.indiana.gov) to aid in determining a website's purpose and credibility. A full collection of these “Nuts & Bolts” lessons, utilized within this study, including researcher-developed scripted lesson plans, tutorials, and PowerPoint's, can be accessed at the following link: <http://tinyurl.com/nuts-boltslessons>.

Next, instruction centered on teaching students how to self-generate questions to form an Internet search query, as this has been shown to significantly impact reading comprehension with traditional texts, even after controlling the variance for prior knowledge (Taboada & Guthrie, 2006). Meeting grade-level standards such as *conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic* (CCSS.ELA-Literacy.W.5.7), or *write informative/explanatory texts to examine a topic and convey ideas and information clearly* (CCSS.ELA-Literacy.W.5.2), participating teachers worked with students to develop inquiry topics under teacher-selected umbrella themes (i.e. notable people or countries) to provide moderate structure, as previously shown effective (Colwell et al., 2013) within the inquiry projects. Intervention lessons involved students grouping questions into categories before selecting focus areas to narrow search queries.

Once topics were selected and focus areas established, students worked to brainstorm, sort, and narrow their query to two, researchable questions within their selected topics (i.e. Martin Luther King). Within lessons three and four, students were taught how to conduct a search query and locate information in online environments through guided practice (phases 1-2 of IRT). Students first learned how to generate effective key words for their query searches, followed by the implementation of the Search Box Strategy (see 21cif.com/tutorials/micro/mm/searchbox) to revise keywords, check results,

and repeat the search until relevant information was located. Lessons five and six afforded students the opportunity to practice this recursive process through independent inquiry (phase 3 of IRT) as students researched their chosen inquiry topics, continually reflecting on their queries using effective key words and practicing taught Internet proficiencies to locate information.

Critical evaluation. As shown in Table 5, a considerable amount of attention during the online lessons was devoted to the development of critical Internet evaluation skills, as past studies imply this is an area of substantial difficulty for students (Castek, 2008; Colwell et al., 2013; Dwyer, 2010; Kuiper et al., 2008; Zhang & Duke, 2011). Students spent five of the 13 lessons working on critical evaluation through questioning the author, checking the accuracy of information, exploring the relevance of copyright, and learning to detect bias within an Internet site. For example, within intervention lesson eight, students investigated the reliability of content by triangulating data with three additional sources. After finding the author of a preselected website, participating teachers modeled how to place the author's name into a search engine to verify the author's legitimacy and qualifications. As such, critical evaluation notability builds on the need to first locate information within the research process. Students worked through challenge tasks within each evaluation lesson to practice, peer-teach, and discuss results and implications. During IRT phase 3, application of this knowledge occurred independently with a systematic evaluation of a student-selected website related to his or her inquiry topic.

Synthesis. To synthesize information from their inquiry research, students utilized online concept mapping (see bubbl.us) to establish relationships between main concepts, subtopics, and details within hierarchical system. Within lessons 12-13, students were taught how to copy/paste categorical information and appropriately cite the reference to later paraphrase into a synthesis response (IRT phases 1-3). Web 2.0 technologies within the school's learning management systems were integrated into the intervention lessons to communicate learned information. For example, students utilized a class blog to post synthesis responses over researched queries and comment on their peers' research findings.

Control Condition: Typical Instructional Activities

To ensure that treatment effects could not merely be driven by level of exposure to technology, students in the control group also utilized the lab or laptops regularly (approximately 60 minutes per week) throughout the duration of this study. The weekly use of the computer labs was comparable to the time afforded to the treatment group. The teachers in the control group were asked to maintain a “business as usual” use of the lab time, implementing typical instructional activities (e.g., typing documents, exploring content websites, playing educational games). As such, students in control classrooms continued to experience standard instruction using computer-based learning consistent with the school’s standards-based curriculum. Although the types of computer activities implemented in the control group varied by teacher preference and curriculum needs, computer access activities did not involve any intervention instruction on the 21st Century online researching skills of locating, evaluating, and synthesizing information.

Treatment Fidelity

A significant concern in field-based intervention research is naturally establishing treatment fidelity for the intervention group. To ensure that the students in the treatment condition were receiving the target content as scripted in the 13 lessons, the first author made weekly checks of the intervention group teacher logs regarding the delivery of the instructional units. In addition to being able to track that the teachers were implementing the programmed instructional modules, the logs provided an opportunity for the teachers to document any problems, concerns, or issues that arose during their instruction. In addition to the printed logs, teachers in the treatment condition had technological support available for using the lab resources and materials that were necessary to display content included in the scripted lessons. Furthermore, the teachers in the treatment condition were asked to provide feedback on their ability enact the instructional materials in the scripted lessons. All teachers (who were randomly assigned to the treatment condition) claimed they were able to implement the lessons using only the provided materials. Overall teachers maintained a high degree of uniform delivery of the online research activity lessons. This was largely promoted by the logistical need to keep the lessons to a specific time frame given tight computer lab scheduling.

Results

To address the two research questions undertaken in this study, we first conducted preliminary analyses examining group differences on the reading performance measures to identify any pre-existing group differences that were not controlled for by the clustered random assignment strategy. Next, regression analysis was employed to identify which variables best predicted performance on the pretest version of the ORCA Elementary-Revised for all participants. Finally, a repeated measures analysis of covariance was employed to explore differential rates of growth for the two conditions on 21st Century online research performance growth, controlling for the influence of traditional reading skills.

Preliminary Analyses

Because complete randomization of assignment to groups was unrealistic in a standard school setting (using only stratified cluster random assignment), an initial examination to determine that equivalent group distribution was achieved was conducted. Exploration of group membership regarding gender, ethnicity, and free/reduced lunch status demonstrated equivalent distribution across the two groups (see Table 6). As such, no further controls for the primary research question related to student demographics were warranted.

To identify group equivalence on the traditional measures of reading and the ORCA Elementary-Revised, another series of one-way ANOVAs was conducted. These analyses indicated the control group outperformed the treatment group on both measures of traditional reading: ELA Proficiency Test, $F(1, 407) = 18.33, p < .0001, d = -.42$; and SRI, $F(1, 415) = 12.23, p < .001, d = -.34$. Furthermore, the control group demonstrated superior performance at pretest on the ORCA Elementary-Revised, $F(1, 415) = 5.68, p < .017, d = -.23$ (see Table 7). Naturally, having disparate literacy skills at the outset of the study posed a significant challenge to the validity of our analyses. To account for these group differences at the outset, we included the two traditional reading measures (SRI and ELA Proficiency Test) as covariates for the primary analyses. This statistical control accounts for pre-existing variance between the groups attributed to the traditional reading measures. As for the pre-intervention differences observed on ORCA Elementary-Revised Pretest, the use of a repeated measures design (which examines both the pretest and posttest values and examines within-subject changes directly) enabled

Table 6. Participant Demographic Information and Pre-Intervention Performances

	N	ELA STATE ^a M (SD)	SRI ^b M (SD)	Pretest ORCA ^c Elementary Revised M (SD)
Gender				
Male	198	503.73 (51.44)	908.86 (225.03)	13.04 (4.89)
Female	219	510.27 (58.51)	911.18 (197.08)	14.24 (5.18)
SES				
Free or Reduced Lunch	67	486.94 (50.34)	833.69 (211.73)	12.73 (4.56)
Paid Lunch	350	510.99 (55.43)	924.70 (207.45)	13.85 (5.15)
Group Status				
Experimental	218	496.12 (43.66)	875.91 (191.92)	13.11 (4.45)
Control	200	519.06 (63.55)	947.15 (223.72)	14.29 (5.63)
Ethnicity				
White/Non Hispanic	310	509.06 (52.48)	924.39 (212.29)	13.36 (4.98)
Black/Non Hispanic	34	472.66 (43.49)	780.88 (174.29)	11.53 (4.45)
Hispanic	10	497.70 (46.77)	807.90 (200.42)	13.30 (4.57)
Asian Pacific Islander	33	521.88 (63.21)	956.94 (198.14)	15.42 (5.65)
Multiracial	31	511.80 (74.98)	884.57 (195.93)	14.50 (5.66)
American Indian	1	523 (0)	979.00 (0)	18 (0)

Note. ^aEnglish/Language Arts Statewide Assessment

^bScholastic Reading Inventory

^cOnline Reading Comprehension Assessment

exploration of the primary research question, which is to identify if the intervention program led to higher levels of growth from pretest to posttest on the ORCA Elementary-Revised as compared to the growth observed in the comparison condition.

Table 7. *Group Means on Traditional and Online Reading Measures*

	Experimental		Control	
	N	Mean (SD)	N	Mean (SD)
ELA ISTEP+ ^a	212	496.12 (43.659)	197	519.06 (63.552)
SRI ^b	217	875.91 (191.916)	200	947.15 (223.721)
Pretest ORCA ^c Elementary Revised	218	13.11 (4.452)	199	14.29 (5.627)
Posttest ORCA Elementary Revised	212	18.17 (5.384)	197	17.83 (5.528)

English/Language Arts Indiana Statewide Assessment Preparation Plus

^bScholastic Reading Inventory

^cOnline Reading Comprehension Assessment

RQ1) Predictors of Initial 21st Century Online Research Performance

The first research question was focused on identifying predictors for 21st Century online research skills, essentially to explore the relevance of these skills in relation to traditional language arts skills and to identify personal difference factors related to noted differences on this measure. To identify which variables predicted students' initial abilities (prior to intervention) in these tasks, we examined the pretest values on the ORCA Elementary-Revised for all participants with linear regression analysis. As these data were all collected prior to the intervention, a single analysis was conducted on the full sample ($n = 418$). The independent variables serving as predictors for ORCA

Elementary-Revised pretest were the two traditional reading measures (State ELA & SRI) and student demographic characteristics (i.e., gender, ethnicity, and socioeconomic status). The results (see Table 8) demonstrated that 21st Century online research performance was reliably predicted by the norm-referenced traditional measures of English/Language Arts ability (State ELA & SRI) as well as student gender and ethnicity. Overall, the variables accounted for 28% of the variance in the ORCA Elementary-Revised pretest values, with the greatest percent of variance explained by the standardized reading measures. While statistically significant, the effects of gender and ethnicity are not strong enough to warrant meaningful attention. However, the results indicated that girls outperformed boys, and students identified as White/Non-Hispanic had higher initial online research skills. These results support the expectation that the 21st Century online research skills are affiliated with standard language arts skills (e.g., reading comprehension, analysis) which provide limited but necessary confirmatory construct validity support for the ORCA Elementary-Revised.

The results of the hierarchical regression analysis identified that gender and ethnicity were weak but statistically significant predictors of 21st Century online research performance. While these effects were weak (and likely only statistical significant due to the power gained from a large sample size), we

Table 8. *Regression Analysis Summary for Predicting ORCA Elementary-Revised Pretest*

	B	SE B	β	t	p
ELA STATE ^a	.028	.005	.304	5.38	.000
SRI ^b	.006	.001	.259	4.62	.000
Gender	.891	.432	.088	2.06	.040
Free and reduced lunch status	-.065	.586	-.005	-.111	.912
Ethnicity	.352	.168	.090	2.10	.037

^aEnglish/Language Arts Statewide Assessment

^bScholastic Reading Inventory

determined it important to ensure that gender and ethnicity did not significantly influence the success of the instructional program. To test this, we ran a multivariate repeated measures analysis of covariance (MANCOVA) that tested the main effects and interactions for treatment condition, gender, and ethnicity on the pretest and posttest values for the ORCA Elementary-Revised while controlling for initial differences demonstrated on the traditional reading measures. The results of this analysis demonstrated that while gender and ethnicity were weak predictors for the ORCA Elementary-Revised pretest scores, neither gender nor ethnicity were associated with changes in performance over the course of the intervention. As such, for simplicity we have presented subsequent analyses without including gender and ethnicity in the model.

RQ2: Effect of 21st Century Online Research Intervention on Student Performance

The second research question addressed the utility of the classroom-based intervention in promoting 21st Century online research skill development. To test the efficacy of the programmed instruction materials, we used a repeated measures analysis of covariance (ANCOVA) to test (a) the main effect of participating in the intervention (21st Century online research lessons for the treatment group, standard curriculum for the comparison group), (b) the main effect examining differences in performance at pretest and posttest (not change scores), and (c) the interaction of growth rates over time and the treatment condition. Thus, the repeated measures ANCOVA allows us to examine the rates of change for the two groups to identify if there are differences in growth rates for the treatment and comparison samples. The use of the covariate (traditional reading ability) also removes the pre-existing differences of general reading aptitude prior to testing the group growth trend differences. Preliminary checks were conducted to ensure there were no violations of assumptions of normality and linearity, homogeneity of regression slopes, and reliable measurement of the covariates. Levene's Test of Equality of Error Variances indicated equal variances for the ORCA Elementary-Revised Pretest ($F=3.38$, $p=.071$) and unequal variances on the ORCA Elementary-Revised Posttest ($F=5.50$, $p=.019$). The large sample size found within this data set increases the power of this study and accounts for the detection of unequal variances (Tabachnick & Fidell, 2007).

The results of the repeated measures ANCOVA demonstrate several findings of importance. First, examination of the covariates revealed that traditional reading achievement was an important factor to be included in order to isolate the effects of the intervention: time x ELA, $F(1, 405) = 2.96$, $p = .086$, $d = .17$, and time x SRI, $F(1, 405) = 9.35$, $p = .002$, $d = .30$. This result demonstrates that the covariates (traditional reading measures) influenced individual student growth on 21st Century online research skills (regardless of group). This essentially demonstrates that students with higher skills in traditional reading activities were able to demonstrate greater gains on the ORCA Elementary-Revised, likely due to applying their advanced skills in reading or a general higher degree of overall academic ability.

Second, the results demonstrated a significant main effect for the repeated factor (time), $F(1, 405) = 5.12$, $p = .024$. This weak but statistically significant effect merely demonstrates that as a whole (comparison and experimental groups combined), students demonstrated gains from pretest to posttest on the ORCA Elementary-Revised. This small positive gain is likely

Table 9. *Unadjusted and Estimated Marginal Means for ORCA Elementary-Revised Total and Subtests*

		Experimental (N=212)		Control (N=196)	
		Pretest	Posttest	Pretest	Posttest
ORCA Elementary- Revised Total	Unadjusted means	13.13	18.17	14.32	17.83
	Estimated marginal means ^a	13.65	18.74	13.76	17.23
Locate	Unadjusted means	4.81	6.56	5.55	6.45
	Estimated marginal means ^a	5.051	6.830	5.296	6.157
Evaluate	Unadjusted means	4.59	5.95	4.49	5.67
	Estimated marginal means ^a	4.738	6.100	4.327	5.511
Synthesize	Unadjusted means	3.81	5.75	4.29	5.67
	Estimated marginal means ^a	3.950	5.898	4.140	5.506

^aCovariates appearing in the model are evaluated at the following values: ISTEP = 507.17, SRI = 911.98

due to a testing effect, general gains in research skills supported by the standard curriculum, or simple maturation effects.

Finally, the primary statistic of interest in this study is the interaction of the experimental condition (treatment vs. control) and the repeated factor of time. This test identifies if the growth from pretest to posttest for the two groups varied, while controlling for the initial differences in ability on the traditional measures of reading. The result demonstrated significantly greater growth for students in the experimental group from pretest to posttest on the ORCA Elementary-Revised, $F(1, 405) = 11.58, p = .001, d = .29$. This outcome is best illustrated through examination of the estimated marginal means displayed in Table 9, which have been adjusted for the pre-existing reading skills measured by SRI and State ELA measures, isolating the effects of the intervention. As such, this analysis demonstrates that the classroom based instruction for 21st Century online research was effective at promoting student skills measured on the ORCA Elementary-Revised during the intervention period, above the expected level of growth that was observed for the comparison group who were engaged in traditional reading instruction activities.

To further explore the performance patterns on the three component parts of the ORCA Elementary-Revised, a repeated measures multivariate analysis of covariance (MANCOVA) was also conducted. Following Castek's (2008) description of tasks embedded within the ORCA-Elementary, three subscales for the ORCA Elementary-Revised were explored (locating, evaluating, synthesizing). Similar to the initial ANCOVA, results demonstrated that students in the treatment group demonstrated significantly greater gains than their control group counterparts from pretest to posttest on the online skills of locating, $F = (1, 405) = 16.50, p < .001, d = .34$, and synthesizing $F = (1, 405) = 5.48, p < .02, d = .23$. No group differences in the gains observed for growth in the domain of evaluating were observed, $F(1, 405) = .597, p < .44, d = .10$ (see Table 9 for means and estimated marginal means).

Discussion

Predicting Student 21st Century Online Research Skills

Our initial research question examined which factors predict ability on the ORCA Elementary-Revised prior to intervention activities. The importance of this analysis is to identify the factors that best predict student differences in

21st Century online research in a standard student population. The results of the regression analysis revealed that prior academic achievement on norm-referenced traditional measures of reading (State ELA and SRI), gender, and ethnicity accounted for 28% of the variance. Examination of the data demonstrates that the standardized measures of reading were the most reliable predictors of students' initial 21st Century online research skills. Put simply, students with strong English-Language arts and reading skills were better prepared to perform on the ORCA Elementary-Revised. This provides some evidence of validation that the 21st Century online research activities are related to standard literacy measures, as well as identifying key factors that predict success in this new literacy domain. This conclusion was bolstered by the results of the ANCOVA that showed significant impact of the traditional reading measures on the growth rates from pretest to posttest on the ORCA Elementary-Revised, demonstrating that students with higher traditional reading skills enjoyed greater gains over the course of the study.

These findings are consistent with prior research that shows traditional and online reading performances were not necessarily isomorphic, but rather require both similar and more complex skills (Afflerbach & Cho, 2010; Coiro, 2011; Coiro & Dobler, 2007). However, there are differential findings in the literature on the relationships among traditional and online reading measures. For instance, Coiro (2011) found a significant correlation between prior reading achievement on standardized reading assessments and her online reading comprehension measures (ORCA-Scenario I and II). Alternatively, a second study reported no relationship between online reading and standardized reading ability assessments (Leu et al., 2005). We believe the discrepancy in the online reading assessment tasks are likely at the base of these differences. For example, an assessment asking students to locate *any website* (ORCA-BLOG; Leu et al., 2005) versus asking students to locate a *specific website* for task questions in the current study may account for divergent findings.

21st Century Online Research Performance Gains

In the primary research question, statistical analyses revealed significant differences between the experimental and control groups in 21st Century online research performance growth. Results of the repeated measures ANCOVA demonstrated significantly greater gains for the treatment group on the overall 21st Century online research measure from pretest to posttest after controlling

for standard reading proficiency. Furthermore, the treatment group advantage was evident in the ORCA Elementary-Revised subskills of locating and synthesizing, with no detectable difference in growth for the skill of evaluation when comparing the treatment and comparison groups' performances on the pre and posttests.

These results make clear that when a standard classroom of students is provided with classroom-based instructional activities that develop online research skills, their 21st Century online research abilities are improved. This significantly greater gain over their randomly assigned comparison peers demonstrates that the growth observed in this intervention is not due to maturation or history effects, and the superior growth for the experimental group can be attributed to the intervention activities. What is important to note for this particular study is that the intervention materials were stand-alone curriculum materials that teachers implemented without ongoing professional development. This ability to impact student performance in 21st Century online research without the need for intensive training or ongoing technical support for teachers is a promising finding for promoting competence in online research skills for all learners.

Locating Information. The difference noted in gains over time for the experimental group in the locating tasks is particularly important to demonstrating the impact of 21st Century online research instruction. Students in the experimental group were more accomplished at locating information within the limited time frame. Experimental group gains in locating were likely attributed to the searching proficiencies taught within the "Nuts & Bolts" lessons. Because each task on the ORCA Elementary-Revised was limited to only 15 minutes, a solid understanding of how to navigate a website was essential. For example, students were asked to communicate the Internet address in three of the four tasks. Understanding a universal resource locator (URL), where to find the URL on a webpage, and how to copy and paste the URL into their responses would greatly increase performance on the locating subskill. Students (e.g., those without the experiences gained in the intervention) who either wrote out the often lengthy URL by hand, toggled between windows to type the URL, or spent time searching for a *contact* address rather than a *website* address, may have dwindled away a substantial amount of task time.

Synthesizing Information. Our findings help add to the limited research in the field on synthesizing as a 21st Century online research skill. The skills assessed in our synthesis measure required students to integrate multiple points of information from a variety of pre-selected websites. Our procedure in Task 4 of our assessment provided a scaffolded process that focused specifically on the task at hand (synthesis), without requiring the students to also locate the websites. While this targeted strategy is more decontextualized than a natural Internet reading situation, it does allow more direct assessment of the primary task (synthesis skill) without the confounding effects of a failure or limitation in locating the information.

Instruction leading up to synthesis, consistent with the IRT model, moved progressively from simple to more complex tasks. As Churches suggests, perhaps synthesis instruction with online text first requires a fundamental understanding of questioning and locating (2009). From choosing an appropriate search engine to developing a researchable question, students utilized basic “Nuts & Bolts” knowledge to locate relevant information (i.e. using the edit-find tool). Students in our study worked to find relationships among resources, create meaning, and craft a written post to a classroom blog. Knowing to first locate and organize appropriate resources may have placed an important role in synthesis performance for experimental group participants.

Critically Evaluating Information. There are a number of possibilities as to why students in this study struggled with higher-level critical evaluation skills. One possible explanation may be the limited amount of time available to critically evaluate Internet information on the ORCA Elementary-Revised. Within the five evaluation lessons, students were taught to evaluate the reliability of Internet content by triangulating the data with three outside sources, investigating the author’s credentials, and screening the site’s content for bias. In Task 4, students had to evaluate three different Internet sites for accuracy and believability. Expecting students to evaluate all three Internet sites within the 15-minute time limit may have been unrealistic for this population of fifth-grade students. A second explanation could relate to a lack of proficiency with gatekeeper skills (Henry, 2006) as well as the notion that online reading skills and strategies are interrelated, recursive, and greatly dependent on each other (Coiro, 2011; Coiro & Dobler, 2007). Because there is a high degree of overlap, the inability to develop effective key terms or decipher search engine results may subsequently hinder critical evaluation. It appears that higher-level

skills are difficult to acquire, and more explicit, direct instruction from the teacher may be needed to increase proficiency in this area (Kingsley & Tancock, 2014).

Implications

The results of this study provide implications for instructional practice as well as add to the growing body of literature regarding 21st Century online research with upper elementary students. Specifically, the findings support prior investigations that identify connections between traditional and online reading processes. Given the growing use of online instructional and informational content for both formal and informal learning, it is imperative to continue to address 21st Century online research skills in standard reading curricula. In addition, our results identified select instructional activities and priorities that were efficiently integrated into a standard curriculum by teachers with limited external support. We offer suggestions based on these observations.

21st Century Online Research Skills as Part of Existing Curriculum

While our study demonstrated that basic 21st Century online research skills (prior to intervention) are related to standard measures of reading performance, the results also clearly identify that explicit instruction of 21st Century online research skills promotes learning and skill development. This illustrates the need to incorporate Internet reading skills into existing content curricula (Coiro, 2003; Leu, Zawilinski, et al., 2007). The definition of text must include both print and online text (Coiro, 2008; Dalton & Proctor, 2008) as online texts include new complexities (Coiro & Dobler, 2007) and amplify the literacy skills an individual needs to comprehend (International Reading Association, 2009; RAND Reading Research Study Group, 2002). For example, instead of using a table of contents, sidebars help students link to alternate concepts. Bookmarking sites and using the “back” button is similar to bookmarking printed text and will prevent students from losing sight of important content (Malloy & Gambrell, 2006). National Education Technology Standards (NETS; International Society for Technology in Education, 2007) have been developed to support effective technology integration in today’s schools. Instructional support, professional development, and indeed even ideas about what curriculum integration means are needed now to help teachers understand and effectively implement these

standards in educational settings (Hutchison & Reinking, 2011; Karchmer, 2001).

IRT as an Effective Instructional Framework

The use of IRT (Leu et al., 2008) as an effective instructional framework for teaching 21st Century online research skills contributes to existing research on RT. Viewing IRT as an updated model of RT may provide an accomplished framework-- supporting both student metacognition and strategic reading of online text. Additionally, placing instruction within a three-phase model can be considered effective for scaffolding students through the Zone of Proximal Development, which is essential to RT (Castek, 2008; Kingsley & Tancock, 2014; Leu & Reinking, 2010). This promotes the use of meta-cognitive strategies specific to online texts (e.g. inferring before opening a hyperlink, triangulating data to critically evaluate Internet-based text). Furthermore, phase two within IRT supports student collaboration to solve online tasks. As noted earlier, students have natural tendencies to collaborate in online environments (Castek, 2008; Henry et al., 2012), and placing the instructor in a facilitator role within Phase 2 and Phase 3 can allow participating students to collaborate and establish active roles in their learning. As one-to-one computing becomes increasingly standard in today's classrooms, contributing research on IRT, such as the data from this study, provides insight on expected outcomes of IRT as a framework to support 21st Century online research skills.

Successful 21st Century Online Research Instruction

Lessons used in this study, were shown effective for improving 21st Century online research for this population of students. Results indicate that teachers could effectively teach 21st Century online research skills in a classroom setting, and that students who received this instruction experienced greater success with these skills than students who did not. The significance of students succeeding with the intervention becomes especially important as this study is the first of its kind, demonstrating that an instructional model accompanied by standardized lessons can promote learning with a large sample of students within an important new area of instruction. Segmenting instruction into a three-phase model, including teacher modeling, guided practice, and Internet inquiry, with instruction progressing from simpler to more complex online tasks can serve as a foundational model for teaching 21st Century online research to today's students. Guided practice and independent

inquiry, incorporated into phases two and three of IRT, may have provided students with a sense of ownership, increased independence, and in turn, maximized learning for this population of students.

Our results indicate that students need more instruction on Internet evaluation, not in isolation, but rather continuously integrated within the IRT model. Indeed, critical evaluation skills may be more effective if lessons are based on a “slow drip” method where discussions and lessons related to the importance of critical Internet evaluation could occur frequently, across all content areas, and throughout the entire school year. This need for a “healthy skepticism” (Leu, Reinking, et al., 2007) when reading online text must become instilled in today’s students to recognize that anyone has the capability to author information on the Internet. Undoubtedly, more research is needed to examine how to best teach and assess the subskill of Internet evaluation. Future studies can help teachers understand not only how to teach critical evaluation successfully but also how best to integrate this instruction to impact student understanding.

Limitations and Future Research

Despite these encouraging results, potential limitations to this study may have impacted the results to a degree. First, the length of study was its greatest limitation. The 12-week continuous duration of the study with eight weeks of intervention lessons may have limited potential achievement gains. Measuring 21st Century online research proficiencies throughout the course of a school year almost certainly would have led to greater opportunity for the initial significant effects we observed to be more solidified. It is believed that a longer intervention period would have enabled the non-significant change in the Evaluation tasks to develop and demonstrate group differences favoring the experimental group. Secondly, the large sample size of predominantly White middle-class students obtained from a single geographic location limits the external validity of this study. Findings may have been different with a more diverse population of students, which was not possible in the context of this study.

Continued attention is warranted for the development of optimal assessments for 21st Century online research. Performance-based measures such as the ORCA Elementary-Revised are difficult to develop due to the inconsistent nature of Internet text, and they are time-consuming to score.

While switching to a multiple-choice assessment would speed up the scoring process and make the use by classroom teachers more viable, such a process would likely lead to limited interpretation of online research ability due to the decontextualized nature of assessment (Castek & Coiro, 2010). However, it is important to recognize that this difficulty is not reserved for online reading and research assessment.

Critics of standardized measures of reading commonly point to the limitations of multiple-choice items typically used to identify student proficiencies. Alternative approaches to assessment in this domain provide meaningful comparisons for consideration and future direction. For instance, the ORCA Elementary-Revised focused on discrete tasks, requiring website specific details to reach full or partial credit. More open-ended approaches to assessing these skills in greater depth provide students with a wider array of possible outcomes, as well as take on additional Internet skills to assess. For instance, measuring synthesis involves an application of a variety of skills. Requiring a more sophisticated definition of synthesis where readers compare and contrast consistent and conflicting information to determine next steps (Goldman, Lawless, et al., 2012) would more authentically assess student performance of this skill. Additionally, incorporating an authentic online communication tool, such as a blog, wiki, or discussion board into the ORCA Elementary-Revised, would provide a definitive examination of communication, a skill students are likely to utilize outside of the classroom and in their future workplaces (Castek & Coiro, 2010; Coiro, 2010; Coiro & Castek, 2010).

Established performance-based measures such as the ORCA-Blog and ORCA-IM (Leu et al., 2005; New Literacies Research Team, 2005), ORCA-Iditarod (Leu & Reinking, 2010), ORCA-Scenario I and II (Coiro, 2011), ORCA-Elementary (Castek, 2008), and the ORCA Elementary-Revised used in this study have only begun to investigate numerous possibilities for online research assessment. Designers of online research measures must consider the age level, reliability of text, and the classroom time constraints teachers face in on a daily basis. More work is needed to determine how to best measure the complexities of online research and expand measures to assess a wide variety of age groups.

While these limitations pose useful domains for future development, the considerable degree of ecological validity that is captured in this study suggests

that the findings in our results are durable and replicable. All intervention efforts were conducted by regular classroom teachers with only minimal curricular guidance through the study materials. Given that these gains were observed relative to a randomly assigned comparison sample from the same school, it is clearly established that the study could be conducted in other educational settings (provided the students had access to online materials), and gains would be expected for all classes participating in the intervention lessons.

Final Thoughts

In sum, this study revealed interventions lessons on 21st Century online research improved performance with a population of fifth-grade students. This is one of the few experimental studies, with perhaps the largest sample of participants, to test the effect of 21st Century online research lessons on online research performance using a complete curriculum designed to support all teachers. There is still much to be learned about the effect of 21st Century online research instruction. While researchers and teachers may not all agree on exactly how literacy is impacted by Internet-based reading, it remains that the Internet is redefining what it means to be literate. National standards and curriculum reform initiatives are calling for an acceleration of students' literacy achievement, focusing on assessment as well as instruction within new contexts such as the Internet. These standards and future assessments raise the bar on education investing in *all* of our nation's youth who must be prepared to effectively use new literacies to compete in an increasingly global and technology-driven future.

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