The Impact of Instruction in the WWWDOT Framework on Students' Disposition and Ability to Evaluate Web Sites as Sources of Information
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THE IMPACT OF INSTRUCTION IN THE WWWDOT FRAMEWORK ON STUDENTS' DISPOSITION AND ABILITY TO EVALUATE WEB SITES AS SOURCES OF INFORMATION

ABSTRACT

Much research has demonstrated that students are largely uncritical users of Web sites as sources of information. Research-tested frameworks are needed to increase elementary-age students' awareness of the need and ability to critically evaluate Web sites as sources of information. This study is a randomized field trial of such a framework called WWWDOT. A matched-pair design involving 12 grade 4 and 5 classes was adopted. Data were collected through 3 assessments administered before and after the intervention: a questionnaire, a Single Web Site Evaluation Task, and a Web Site Ranking Task. ANCOVA and ordinal regression analyses reveal that students taught the WWWDOT framework became more aware of the need to evaluate information on the Internet for credibility and were better able to evaluate the trustworthiness of Web sites on multiple dimensions. However, students' overall judgment and ranking of the relative trustworthiness of Web sites was not improved.

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THE Internet has become a part of many people's daily lives. Nearly all U.S. public schools have access to the Internet (National Center for Education Statistics [NCES], 2005), as do the majority of U.S. households (U.S. Census Bureau, 2011). Not only do students have access to the Internet, as of 2002 more than 60% use it (Arafeh, Levin, Rainie, & Lenhart, 2002). Schoolwork is among the most common foci of students' Internet use (Lenhart, Simon, & Graziano, 2001;

NCES, 2006). At the elementary level specifically, as of 2000, 31% of teachers reported assigning research using the Internet (NCES, 2000). Although we were unable to find study findings on teachers' assignment of Internet research more current than 2000, our experiences working with teachers in schools in recent years suggest that subsequent surveys will likely reveal even greater proportions.

The Internet provides a great deal of information. However, unlike printed text that is published, most of the information on the Internet is unfiltered; it generally has not gone through processes of screening or sanctioning by editors, publishers, librarians, and so on. This makes it even more important for students to be aware of the need and to know how to evaluate the quality of information they encounter online. Research shows that many students do not take a critical view when they read on the Internet (e.g., Hoffman, Wu, Krajcik, & Soloway, 2003; Kafai & Bates, 1997; Killi, Laurinen, & Marttunen, 2008; Kuiper, Volman, & Terwel, 2005; Lorenzen, 2001; New Literacies Research Team & Internet Reading Research Group, 2006; Wallace, Kupperman, Krajcik, & Soloway, 2000). In fact, students often regard information on the Web as of higher value and authority than its print counterpart (Schacter, Chung, & Dorr, 1998). With information on the Web, it is even more crucial than for print texts for students to realize the need and the ability for critical evaluation of the quality of the information presented (Eagleton, Guinee, & Langlais, 2003; Leu, 2002).

The call to teach students how to critically evaluate Web sites as sources of information has been taken up in a number of professional resources (e.g., Eagleton et al., 2003; University of California, Berkeley, 2009) and research projects (e.g., Baildon & Baildon, 2008; Davis & Kirkpatrick, 2002; Graesser et al., 2007; Iding, Landsman, & Nguyen, 2002; Quintana, Zhang, & Krajcik, 2005). However, controlled studies to test the efficacy of specific frameworks for teaching Web site evaluation at the elementary level are needed.

The purpose of this study was to test WWWDOT, a framework for improving elementary school students' awareness of the need and their ability to evaluate Web sites as sources of information, in a randomized field trial. This framework was designed to develop students' disposition to evaluate Web sites—a fundamental and especially appropriate step for elementary-age students—as well as to help students learn to evaluate Web sites on at least six dimensions: authorship, currency, purpose, organization, whether the Web site meets the students' needs, and what to do after reading (e.g., additional material to read).

Rationale and Review of the Literature

Students Tend Not to Critically Evaluate Web Sites

Much research has been done on students' reading behavior on the Internet. Results consistently show that students rarely evaluate the reliability and authority of information on the Web (Hirsh, 1999; Hoffman et al., 2003; Kafai & Bates, 1997; Kuiper et al., 2005; Lorenzen, 2001; New Literacies Research Team & Internet Reading Research Group, 2006; Slone, 2002; Wallace et al., 2000; Walraven, Brand-Gruwel, & Boshuizen, 2009).

A survey of Internet usage and online reading found that only 4% of students reported checking the accuracy of information found on the Web at school, even as

late as middle school; only 2% of students reported doing so outside of school (New Literacies Research Team & Internet Reading Research Group, 2006). For these middle school students, Henry (2007) found that, among Internet reading tasks, critical reading tasks were especially challenging. For example, less than 15% responded correctly to a survey item that "measured critical evaluation of the reliability of an information source" (Henry, 2007, p. 128). Together, studies suggest the importance of teaching students about the need to evaluate the trustworthiness of information on Web sites and appropriate criteria for doing so (Agosto, 2002; Lorenzen, 2001).

Critically Evaluating Web Sites Includes Matching the Information Resources with Needs

In addition to teaching students to evaluate the credibility of Web sites, it is also crucial to teach them to evaluate the relevance of information on Web sites, that is, to decide whether the information on the Internet meets their needs (Henry, 2007). Readers are sometimes distracted by visually attractive Web sites (Agosto, 2002); this sometimes results in readers forgetting to think about their original purpose or goal for reading the sites. Evaluation of Web sites should also include consideration of the readability and accessibility of the site (Baildon & Baildon, 2008; Henry, 2007), although elementary students' ability to assess this accurately may be limited.

Research-Tested Approaches Are Needed to Improve Students' Critical Evaluation of Web Sites

Teachers, technology specialists in schools, researchers, and many others have been calling for training students to critically evaluate information on the Internet (Baildon & Baildon, 2008; Davis & Kirkpatrick, 2002; Graesser et al., 2007; Iding et al., 2002; Quintana et al., 2005). Some have proposed, and in some cases researched, ways to do so (Burke, 2000; Eagleton & Dobler, 2007; Hawes, 1998; Henry, 2007; Schrock, 1999). For example, Hawes (1998) suggested asking students a list of questions that could help them analyze the information they found on the Internet. Schrock (1999) argued that teachers should teach students to evaluate Web sites from three perspectives: authority of author; content, bias, and authenticity of information; and presentation. Baildon and Baildon (2008) suggested having students ask themselves questions including, Can I understand the information on my own? Is the information current? Can I find at least one other source with the same information? After explicit instruction in these questions, Baildon and Baildon found that students in their fourth-grade classroom were more likely to analyze Web sites based on readability, trustworthiness, and usefulness. They were also less likely to say they would use a problematic Web site that was presented to them. This and other literature suggests that teaching students to evaluate Web sites as sources of information is needed and possible. However, randomized field trials (e.g., Towne & Hilton, 2004) are needed to measure the impact of specific approaches to teaching Web site evaluation at the elementary level.

Theoretical Framework

This study is informed by a new-literacies perspective (Leu, 2002; Leu, Kinzer, Coiro, & Cammack, 2004) and the concept of critical literacy (Burbules, 1997; Lankshear,

1997). According to the new-literacies perspective, the ability to construct meaning in multimodal textual environments is a basic and essential skill of the digital age, one that should be central in classroom instruction (Lankshear & Knobel, 2003; Leu et al., 2004). The new literacies of the Internet and other information communication technologies (ICTs) include the skills, strategies, and dispositions necessary to identify important questions; locate, critically evaluate, and synthesize information; and communicate information to others. Critical evaluation of information is the focus of this study. As such, some concepts from critical literacy perspectives guide the work. Critical literacy includes, among other things, critical thinking about the meaning of information in general, including information that comes from the Internet (Burbules, 1997; Lankshear, 1997; Lankshear & Knobel, 2003). Critical literacy includes the need for readers to understand the positioning of a text—why and from what perspective it was written—and to approach the Internet with a selective, evaluative, and questioning stance (Burbules & Callister, 2000). We believe that the elementary level is the ideal time to develop awareness of the need to critically evaluate Web sites as sources of information.

The WWWDOT Framework

Evaluating Web site credibility is a highly complicated process (Zhang & Duke, 2008). During this complex process, different factors weigh differently. For example, an outdated Web site written by a credible source may be more trustworthy than an updated Web site written by a person without appropriate credentials. Credibility is a continuum with the most trustworthy on one end and the least trustworthy on the other. The WWWDOT framework is an effort to make students aware of some key dimensions that they can collect information on to help them place Web sites on this continuum.

The WWWDOT framework was designed to support students' critical evaluation of information on Web sites by encouraging them to think about at least six things when considering using a Web site for information: who wrote it, why it was written, when it was written, does it help meet my needs, organization of the site, and to-do list for the future (see Table 1). The acronym was thought to make the tool easier for elementary students and teachers to remember. Acronyms have been used successfully in teaching other routines for learners to engage in (e.g., Graham & Harris, 2005). We selected these particular dimensions based on what we viewed as likely to be most useful and appropriate for elementary-age students. For example, we deliberately chose not to include consulting background knowledge, as elementary-age children often do not have background knowledge that would serve as a good guide for evaluating Web sites. Thus, we emphasized evaluation using other means, including corroboration with other Web sites. Although these elements are listed and taught separately, they are certainly interrelated.

Who Wrote This and What Credentials Do They Have?

Identifying authorship and authors' qualifications and examining authors' perspectives and funding sources are critical for any type of reading, but this act seems even more pertinent when reading in the environment of the Internet, where there are often no filtering or sanctioning bodies for publishing (American Library Asso-

Table 1. The WWWDOT Framework

WWWDOT	Some Key Teaching Points
Who wrote this and what credentials do they have?	• Check author's name, credentials, contact information. • If no author is identified, check who sponsors the Web site. • If no sponsor is identified, check signs of qualification of author such as self-contradictions or spelling/grammatical mistakes.
Why did they write it?	• Be aware of possible purposes of writing: to entertain, to share, to support, to inform, to educate, to sell, and to persuade. • Be aware that one topic can be approached differently with different purposes.
When was it written and updated?	• Understand there are three categories of works: timeless, limited life, time sensitive. • Understand that timeliness may also reflect whether the author is still maintaining the site.
Does this help meet my needs (and how)?	• Ask questions, including: Does the site give the type of information that I need? Is it too difficult for me?
Organization of Web site	• Be aware that knowing how a Web site is organized helps readers to navigate and find information. • Be aware that knowing how a Web site is organized can help readers understand the content
To-do list for the future	• Have a plan, which may help diminish distraction. • Use a to-do list to keep track of additional Web sites and other sources to achieve a better understanding of the topic.

ciation [ALA], 2011; Burbules & Callister, 2000; Burke, 2000; Eagleton & Dobler, 2007; Hawes, 1998; Schrock, 1999).

Why Did They Write It?

Regardless of who the author of a Web site is, it is important to judge whether he/she or the organization provides thorough and accurate information (Burbules & Callister, 2000; Hawes, 1998; Schrock, 1999). Generally speaking, thoroughness and accuracy are to a large degree dependent on the writing's purposes, such as to entertain, share, support, inform, educate, sell, and persuade (Burke, 2000).

When Was It Written and Updated?

Some information, especially news and technology, is outdated very quickly. Some has a longer but still limited life because of rapid advances in its field, such as psychology or biology, among others (Harris, 2007). Therefore, it is important to note when information on a Web site was written or updated (ALA, 2011; Eagleton & Dobler, 2007). In addition, the timeliness of a Web site reflects whether the author is still maintaining an interest in the page, or has abandoned it. This can also be one of the criteria to assess the usefulness of a Web site.

Does This Help Meet My Needs? (and How?)

Readers need to evaluate Web sites to see whether and how they meet their needs (Henry, 2007). A question that readers can ask as they get an overview of a Web site and before they dig deeply into specific parts of the site is, does it provide the type of information that I need? It is also important to judge the reading level of the materials (Henry, 2007). Many Web sites are beyond the reading level of most elementary

school students (Kamil & Lane, 1998). Even if a Web site is trustworthy and provides information that a student needs, it may be too challenging for the student to use effectively.

Organization of the Web Site

Having an idea of how a Web site is organized is crucial (ALA, 2011; Schrock, 1999). The structure of a Web site plays an important role in helping readers navigate through the site and read information on it (Calisir & Gurel, 2003; McDonald & Stevenson, 1998; Nimwegen, Pouw, & Oostendorp, 1999; Rouet & Levonen, 1998; Waniek, Brunstein, Naumann, & Krems, 2003). Getting familiar with the organization of a Web site helps readers understand the content (Coiro & Dobler, 2007). Furthermore, given that graphs and photos can enhance or supplement the content (Baskin, 1997; Card, Mackinlay, & Shneiderman, 1999; Larkin & Simon, 1987), by noticing where the graphs and photos are, readers could intentionally seek help from them to enhance their understanding of the other information presented on the Web site (Zhang & Duke, 2008). A poorly laid out Web site suggests at least an unprofessional approach to Web publishing and reduces its trustworthiness as well as its utility.

To-Do List for the Future

One important way to evaluate the trustworthiness of a source is to compare the information it provides with the information provided by other sources. Indeed, we found that good adult Internet readers often looked across multiple sources to verify information (Zhang & Duke, 2008). The to-do list for the future is designed in part to encourage this behavior.

In addition, developing a plan for future activities while reading Web sites may help readers manage their learning. Readers can easily become disoriented by the vast amount of information on the Internet, lose track of sites to which they could return or other resources they could use, or forget other activities that could enhance their learning of the topic (McDonald & Stevenson, 1998). The plan, if developed while reading a Web site, can include additional texts suggested by the Web site for later reading. It can also include activities that could help readers understand a certain topic in other ways, such as asking a librarian a question, sharing what they learn about the topic with others, and so on.

Research Question

This study was designed to address the following research question: What is the impact of instruction in the WWWDOT framework, if any, on fourth- and fifth-grade students' awareness of the need and ability to critically evaluate Web sites as sources of information?

Method

We used an experimental design to assess the impact of teaching fourth- and fifth-grade students the WWWDOT framework. Paired randomization was used in assigning control and experimental groups. In the control group, students did what

Table 2. Demographic Statistics of the Participating Students

Variable	N	%
Gender:		
Female	136	56.2
Male	106	43.8
ESL status:		
Yes	3	1.2
No	224	92.6
Missing	15	6.2
Special ed.:		
Yes	37	15.3
No	190	78.5
Missing	15	6.2
Grade:		
4	123	50.8
5	119	49.2
Age (in years):		
8	3	1.2
9	55	22.7
10	111	45.9
11	53	21.9
12	2	.8
Missing	18	7.4

they normally do during the equivalent time of the day. In the experimental group, classes were taught the WWWDOT framework in four 30-minute lessons. Several assessments were administered to both groups before and after the intervention to test whether teaching the WWWDOT framework to fourth- and fifth-grade students had an impact on their awareness of the need and their ability to critically evaluate Web sites as sources of information.

Participants

Students. A total of 242 fourth- and fifth-grade students in 12 classes from three schools in three school districts within the same geographic area participated in this study. Demographic statistics of the participating students are presented in Table 2. Eight classes were from a suburban school, two were from a rural school, and another two classes were from an urban school. Mean consent rates for the control and experimental groups were 81% and 83%, respectively. Only two students (of 228 valid responses) indicated that they had never used the Internet, and only 15 students (of 221 valid responses) reported that they did not have Internet access at home, with no statistically significant differences by condition. Fourth- and fifth-grade scores on the Michigan Educational Assessment Program from the three participating schools indicate that 80%–97% of students in the participating schools were proficient in reading.

For the 12 classes, there were six teachers: two computer teachers (one with four classes, one with two), two full-day classroom teachers, and two classroom teachers who switched students for some subject areas (having two classes each). Given the relatively small sample and heterogeneity of participating schools and districts, classes were placed in matched pairs on the basis of demographic characteristics of the student population. Then, within each pair, one class was randomly assigned to

the experimental condition. When there was more than one class taught by the same teacher, classes were designated as a matched pair, which not only matched student demographics but also served to hold the teacher's impact constant across conditions. In total, three fourth-grade classes and three fifth-grade classes were randomly assigned as experimental, and four fourth-grade classes and two fifth-grade classes served as controls. Data analyses suggest no difference between grades on study measures.

Teachers. A survey of participating teachers showed a mean of 10.8 years of K–12 teaching experience (range 3–34) and a mean of 6.8 years of experience at the grade levels they were teaching (range 1–26). Five had a master's degree. Two had a degree in technology education.

Based on the survey, the teachers had their students on the Internet for 52 minutes each week on average, with a range of 0–90 minutes. Only one of the teachers reported teaching students how to read on the Internet, and she reported spending 1.4 minutes on average teaching Internet reading each week.

Treatment and Control Procedures

The experimental group. In the experimental group, students learned the WWWDOT framework in four 30-minute lessons. This intervention is intentionally brief. We believed a brief intervention would have a better chance of being successfully disseminated if it proved effective. At the same time, we recognize that such a brief intervention has less of a chance of showing effects.

The four sessions' lesson plans were read through and piloted by four experienced fourth-grade teachers with teaching backgrounds and current teaching positions similar to those of the teachers participating in the current study. Lesson plans were revised based on pilot work. Lessons are described below.

Lesson 1. Teachers explained to students that everyone can publish on the Internet. Then they invited students to comment on the possible problems of some of the information on the Internet. Following the comments, teachers emphasized the importance of critically evaluating Web sites and asked students to think what aspects they should pay attention to when evaluating Web sites' trustworthiness. Teachers also showed students some hoax Web sites. Then teachers introduced the WWW-DOT framework using a PowerPoint slide and called students' attention to the name of the framework as an acronym. Teachers used another slide to explain WWW (who, why, and when). For each W, teachers gave two or three researcher-selected example Web sites on immigration (a topic commonly taught in the state at these grade levels) and invited students to find the relevant information and make comments.

Lesson 2. Teachers asked students what the WWWDOT framework was for and what WWW was. Then they explained the DOT part of the framework with two or three researcher-selected example Web sites for each element. While reading the example sites for each element of DOT, teachers asked students to comment on the relevant element and the WWW of the framework. As with lesson 1, this was a whole-class interactive lesson led by the teacher.

Lesson 3. Teachers reviewed why it was necessary to evaluate the trustworthiness of Web sites and all six elements of the WWWDOT framework. Then they handed out three WWWDOT worksheets (Fig. 1) to each student and asked the students to

Grade Level _____ Name _____ Date _____

URL _____

WWWDOT: A Tool for Supporting Critical Reading of Internet Sites
[lines/space provided for writing/drawing are deleted for space]

Who wrote this (and what credentials do they have?) [five lines provided for writing]
Why did they write it? [five lines provided for writing]
When was it written and updated? [four lines provided for writing]
Does this help meet my needs (and how)? [five lines provided for writing]
Organization of site (you can write and/or draw.) [seven short lines provided for writing and space provided for drawing]
To do list for the future [five full-length lines provided for writing]

Figure 1. WWWDOT worksheet.

evaluate three researcher-selected Web sites on the Underground Railroad. Each student worked on one computer with the links to the three Web sites on the screen. Students could talk to one another while they worked on completing the worksheets.

Lesson 4. Students began by finishing work on the WWWDOT worksheets from lesson 3. Then, teachers asked students to have a debate on the trustworthiness of each Web site. Teachers briefly explained the difference between a debate and an argument and showed students each Web site using a projector. Students used the WWWDOT framework to reason whether each Web site was or was not trustworthy and why.

Web sites used and instruction. All Web sites used in teaching were authentic rather than researcher written. Given that there is as yet no well-established system for specifically judging Web site readability, the Simplified Measure of Gobbledygook (SMOG) Reading Level Calculator (a formula that estimates the years of education needed to understand a piece of printed text) was used. It showed that the reading level of the Web sites' text was approximately fourth and fifth grade.

Teachers who were assigned to teach the WWWDOT framework in the experimental classes participated in a 2-hour professional development workshop before the intervention. They learned about the rationale for this study, the importance of teaching students to evaluate Web sites, the WWWDOT framework, and how to teach students this framework. The researchers and the teachers went through the lesson plans for the four 30-minute sessions together and learned how to use the Web sites in the lesson plans.

Three teachers completed the intervention during a 2-week period (two 30-minute sessions per week) and the other three finished it within 1 month (one 30-minute session per week). Analyses revealed no differences in findings between classes who completed the intervention during a 2-week period and those who completed it during a 1-month period.

The Control Group

The control group teachers were asked to do what they would normally do during the time the experimental group was having WWWDOT sessions—that is, to teach

as originally planned. Three control classes had their regular computer class activities. During the two sessions the researchers observed, students in these three control classes spent most of their time editing pieces they were writing about what they would like to be when they grow up. They also searched the Internet for images of the profession they were writing about. Another three control classes received content-area instruction as they normally would. The content and activities during the two sessions when the researcher observed did not involve use of the Internet.

Monitoring Implementation

The first author observed each experimental class for one of the two WWWDOT lessons and one of the two WWWDOT practice sessions. Control classes were observed twice during the equivalent times. The researcher observed for 30 minutes each time, coding any class activity related to what was specified in the WWWDOT lesson plans.

Experimental group teachers were observed staying close to the WWWDOT lesson plans. The total number of aspects of each of the six components of WWWDOT addressed by the experimental teachers during the two observations of each experimental classroom ranged from 11 to 21. In contrast, in the control classrooms, only two teachers addressed any of the issues listed on the protocol at any time. These two teachers taught their students how to identify their needs while searching on the Internet. A t test of the mean number of WWWDOT components addressed showed that the experimental group provided more instruction in Web site evaluation than the control group at a level of statistical significance ($t = 6.168$, $df = 12.462$, $p < .001$).

Assessments

No previous assessments to measure elementary-age students' Web site evaluation skills were found; thus the researchers designed all assessments used in the study (Baildon & Baildon [2008] have since published measures used in a fourth-grade classroom in Singapore). The assessments included a questionnaire, a Single Web Site Evaluation Task, and a Web Site Ranking Task. All were piloted multiple times for content, wording, and duration with students in schools in which no class participated in the project. We revised assessments based on observations during piloting.

Questionnaire. A questionnaire was designed to measure (*a*) students' awareness of the need to critically evaluate Web sites as sources of information, (*b*) students' Web site evaluation skills, including the six aspects of WWWDOT, and (*c*) students' basic skills in using a browser and seeking information on the Internet (not a target of instruction in WWWDOT but a possible covariate). It consisted of 18 five-point Likert-scale items. For example, one item states, "As long as the Web site contains information I am looking for, I do not care who wrote the Web site." Another states, "While I read things on the Web site, I am aware of the author's purpose of writing/creating it." Following each item, five choices were given: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. In designing the questionnaire, the researchers used positive statements and negative statements to avoid having either end of the scale—strongly agree or strongly disagree—consistently most desirable. No time limit was given. Internal consistency of the questionnaire

Single Website Evaluation Task, Form A

Suppose that you are looking for information about Pandas on the Internet and come across the following website. Please read the **first page closely** before clicking on any links. You can scroll all the way to the bottom of the page as you read. Please write one paragraph telling about **whether you should trust and use the information on the site and why**. You have 25 minutes to finish this task.

While reading the website, you may browse the other pages of the website a little bit, but please focus mainly on the first page.

While writing about whether you should trust the information on the website and your reasons, you do not need to pay a lot of attention to spelling, grammar, or handwriting. For this task, **a rough draft is fine**.

[Link to the website]

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Figure 2. Example, Single Web Site Evaluation Task.

has a Cronbach's alpha of .728. As items were designed on a 5-point Likert scale, students' responses to each item were given a number from 1 to 5 depending on the most desirable response.

Single Web Site Evaluation Task. The Single Web Site Evaluation Task (Fig. 2) was designed to measure how students evaluate Web sites as sources of information. First, the students were asked to browse a Web site and make a judgment about whether or not the information on it was trustworthy. Second, the students were asked to write one paragraph telling why they should trust or should not trust the information on the site.

Web sites used for this task were actual Internet Web sites that could be accessed from schools (despite filters) if their topic was searched for on the Internet. All Web sites contained not only text but also media such as graphs, animations, images, or video. In addition, each site met the following criteria: (1) it was on a topic likely to be of interest to elementary students and (2) it was relatively trustworthy in some respects and not very trustworthy in other respects (so students could show a range of evaluation skills). To avoid a familiarity effect, two equivalent forms were designed. To keep the two forms as equivalent as possible, we kept the instruction/scenario and the topic of the Web site on each form the same. The only difference between the two forms was the Web site link. By random assignment, half the students in each class had one form at pretest and the other half had the other form at pretest; students took the alternate form at posttest. Students were given 25 minutes for this assessment.

For each student, two scores were given. One was the score for their overall judgment about whether or not they thought information on the Web site was trustworthy. For this, a student could receive 0, 1, or 2 points. Using criteria including (*a*) the update year, (*b*) the author's credentials, (*c*) the purpose of the site, (*d*) the informa-

tion source, (*e*) the presence of spelling or grammatical mistakes, and (*f*) the presence of nonworking links, the researchers and four experts reviewed the two Web sites and judged the Web site of form A to be trustworthy in some respects and not in others, and overall to be only slightly more trustworthy than less. They also judged the Web site of form B to be trustworthy in some respects and not in others, but judged it to be clearly more trustworthy than less. Therefore, for form A the response "yes and no" received a score of 2, whereas for form B the response "yes" received a 2. For form A, the response "yes" received a score of 1, whereas for form B the response "yes and no" received a score of 1. In both cases, the response "no, I don't trust it" received a score of 0.

The second score for this task was given based on the reasons the student provided for why one should or should not trust and use information on the site. Responses were scored based on whether they showed that (*a*) the student identified an appropriate thing to look at for the purpose of evaluation of the Web site as a source of information (e.g., the date when the Web site was updated) and (*b*) the student used a good strategy for evaluation (e.g., examining the credentials of the author of the site). A student's total score is a score for the number and quality of reasons given on the reason part of this assessment. Scores ranged from 0 to 12. Scoring was conducted by two raters blind to condition and blind to pre and post. The interrater reliability between these raters, based on a random sample of 42 samples across condition and assessment time, was 93.5%.

Web Site Ranking Task. This task was designed to test whether students were able to distinguish relatively trustworthy Web sites from relatively untrustworthy Web sites and to identify how they made the distinctions. First, students were asked to rank four Web sites from the most trustworthy to the least trustworthy. Second, students were asked to write one paragraph about why they chose one as the most trustworthy and write another paragraph about why they chose another as the least trustworthy. Web sites were chosen for this task on the same bases as for the Single Web Site Evaluation Task, with the addition that we aimed to maximize the difference in trustworthiness among sites used in the task. Again, two forms of the assessment were developed, with form counterbalanced within classroom (see Fig. 3). Students were given 30 minutes to complete this assessment.

For each student, three scores were given: a score from 0 to 6 for Web site ranking, a score from 0 to 12 for the reasons for ranking a site as the most trustworthy, and a score for the reasons they gave for ranking a site as the least trustworthy. Reason scoring was done by two raters blind to condition and blind to pre and post. Based on a random sample of 42 pieces across condition and pre and post, interrater reliability was 92.3%.

Administration of Assessments

In both groups before and after the intervention, the questionnaire was administered first, followed by the Single Web Site Evaluation Task and then the Web Site Ranking Task. All preassessments were completed within 2 to 3 weeks before the intervention, and all postassessments were completed within 2 to 3 weeks after the intervention. Assessments were administered by the researchers with assistance from the teachers using detailed assessment protocols.

Website Ranking Task, Form A

Suppose you are searching for information about the Respiratory System and you find the following 4 websites. During the next 30 minutes, please:

1. Check out the websites, **browsing them a little bit**. Please read the **first page for at least 5 minutes** before clicking on any links. You can scroll all the way to the bottom of the page as you read.
2. Rank the websites based on how much you can trust the information in them.
3. Write down the reasons why you trust one the most and another the least.

While writing, you do not need to pay a lot of attention to the spelling, grammar, or your handwriting. For this task, a **rough draft is fine**. **Please write down all the reasons you have in mind.**

[Link to website A]
[Link to website B]
[Link to website C]
[Link to website D]

Please circle one for each category.

Most trustworthy: A B C D
Second most trustworthy: A B C D
Third most trustworthy: A B C D
Fourth most trustworthy: A B C D

Take a look at the website that you ranked as the most trustworthy and write down your reasons.

Take a look at the website that you ranked as the least trustworthy and write down your reasons.

Figure 3. Example, Web Site Ranking Task.

Analysis Procedures

The Statistical Package for the Social Sciences (SPSS, version 13.0) was used to analyze data. For data collected through the questionnaire, the judgment score and the reasoning score (separately) of the Single Web Site Evaluation Task, and the reasoning part of the Web Site Ranking Task, ANCOVAs (analyses of covariance) were used to estimate the effect of the intervention, if any. Data from the three assessments were analyzed and modeled individually. For each model, preassessment scores were checked and found to meet the ANCOVA assumption of homogeneous regression slopes.

For the questionnaire data, an overall score was used in the data analysis with ANCOVA. Then, in order to find out if there was any effect of the intervention on different aspects of the participants' awareness and evaluation skills, an ordinal regression model (PLUM) was used to analyze data obtained from each individual item.

For the ranking scores, an ordinal regression model with the logit link (proportional odds model) was used to test the effect of the intervention on all levels of ranked categorical outcomes (Bender & Benner, 2000). The assumption of parallel

Table 3. Means, Standard Deviations, and Means Adjusted by Pretest Scores for Study Outcome Measures

| | Preassessment | | Postassessment | | |
Condition	M	SD	M	SD	Adjusted M[a]
Questionnaire:					
Experimental	61.57	6.394	68.689	6.935	68.619
Control	61.58	6.199	63.333	6.662	63.319
Single Web site overall judgment score:					
Experimental	.992	.680	1.002	.826	1.014
Control	.896	.573	.909	.788	.899
Single Web site reason score:					
Experimental	1.56	1.861	4.02	2.831	3.877
Control	1.22	1.718	1.30	1.506	1.373
Web site ranking reason score:					
Experimental	1.07	2.08	5.48	5.00	5.50
Control	1.07	2.50	1.67	2.34	1.65

[a] Adjusted mean is a mean adjusted by the pretest score.

lines across all levels of the ranking outcome was met. A $p < .05$ level of statistical significance was used in all the models adopted.

ANCOVA and ordinal regression were run comparing outcomes for classes taught by computer teachers to outcomes for classes taught by regular classroom teachers. No interaction effect was found between the classes taught by these different types of teachers, and results are reported for classes of the two types of teachers combined.

Results

Recall that the research question for this study was, what is the impact of instruction in the WWWDOT framework, if any, on fourth- and fifth-grade students' awareness of the need and their ability to critically evaluate Web sites as sources of information? The results show that just four 30-minute sessions of instruction in the WWWDOT framework did make fourth- and fifth-grade students more aware of the need to evaluate information on the Internet for credibility and better able to evaluate the trustworthiness of Web sites on multiple dimensions. However, the students in the experimental group did not perform better in overall judgment and Web site ranking than those in the control group.

Questionnaire

There was a significant effect of instruction in the WWWDOT framework on participants' postassessment scores after controlling participants' preassessment scores, $F(1, 198) = 42.06$, $p < .01$, $r = .42$. Table 3 presents the means, standard deviations, and means adjusted by preassessment scores by assessment time and condition for this and all outcome measures.

To further explore the effects of instruction in the WWWDOT framework on students' concepts of Web site credibility and their evaluation skills, we used an ordinal regression model with data for each item of the questionnaire. Because some

category cells were empty, the chi-square goodness-of-fit statistic was not valid; therefore, conclusions from the results of the ordinal regression model are merely suggestive and should be interpreted with caution. After controlling for the preassessment scores, the coefficients for the instruction in the framework were positive and significant for all the variables except for items 1, 2, 11, 13, and 15. The findings from ordinal regression analyses of individual questionnaire items suggest that instruction in the WWWDOT framework (*a*) helps students be more aware of the existence of untrustworthy information on the Internet; (*b*) improves the experimental group's Web site evaluation skills in identifying authorship of Web sites, noticing currency of information on Web sites, noting existence of different purposes for creating a Web site, attending to organization of Web sites, and having a plan about what to do next while browsing a Web site; (*c*) does not help students take their own needs into consideration while browsing a Web site; (*d*) does not improve students' confidence in their self-perceived evaluation skills (on the contrary, there was a slight, not statistically significant decrease in experimental group students' self-perceived Web site evaluation skills); and (*e*) does not have an impact on their browsing skills (we did not expect it would, as that was not a focus of the intervention).

Single Web Site Evaluation Task

Recall that there were two scores for the Single Web Site Evaluation Task: one for participants' overall judgment of the trustworthiness of a Web site, and one for reasons participants gave for why they should or should not trust a Web site. The two scores were not significantly correlated ($r = .102$, $p = .127$), and two ANCOVAs were run separately to examine if there were any effects of the intervention on the two scores.

Judgment score. There was no significant effect of instruction in the WWWDOT framework on participants' postassessment judgment scores after controlling for the effect of participants' preassessment judgment scores, $F(1, 209) = .755$, $p = .386$, $\eta^2 = .004$ (see Table 3).

Reason score. The covariate, the students' preassessment reason score, had a significant effect on the postassessment reason score, $F(1, 209) = 27.864$, $p < .001$, $\eta^2 = .09$. There was also a significant effect of instruction in the WWWDOT framework on participants' postassessment reason scores after controlling for the effect of participants' preassessment reason scores, $F(1, 209) = 72.498$, $p < .001$, $\eta^2 = .23$ (see Table 3 and Fig. 4). The mean postassessment scores were 5.45 for the experimental group and 1.60 for the control group. Postassessment examples from an average scorer from each group follow.[1]

Lauren, an average scorer randomly selected from an experimental class, scored 6 for her reasons (some corrections were made for readability). Rater's comments in brackets explain the scoring:

> From the information I would think that it is true, but the website was by Jian Mu a graduate, but who knows who that person is. It is not someone you know like the History Channel. [*3 points for having identified an appropriate thing to look at, that is, the author of the website; located the correct information, Jian Mu; and appropriately linked information about the author to the trustworthiness of the website.*]
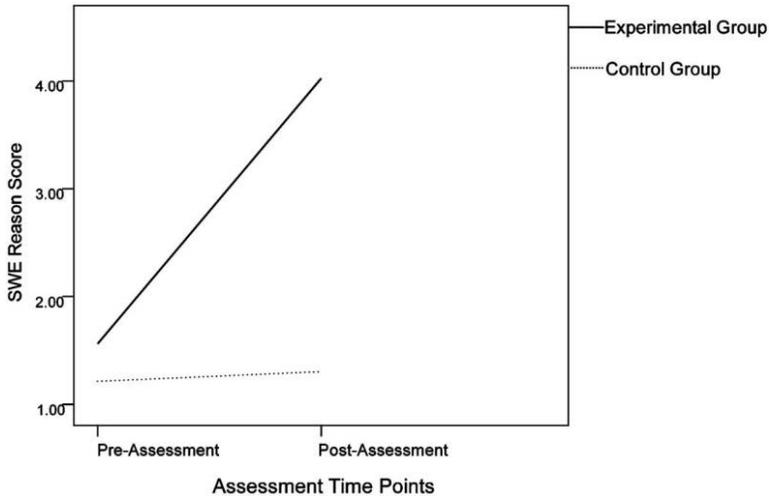
Figure 4. Comparison lines of pre- and postreason scores: Single Web Site Evaluation Task.

But other than that all the information is probably true like the panda living in China. But the pictures look like paintings not real. And in one of the pictures the panda is in a comic made of veins. [*3 points for having identified an appropriate thing to look at, that is, whether the pictures look realistic or not; gotten the correct information, that is, the picture is not realistic; and appropriately linked the issue of the pictures to the trustworthiness of the website.*]

Amy, an average scorer randomly selected from a control class, scored 3 for her reasons: "I can trust this information because I think it sounds true. Like it said Panda Bears are found in parts of South China, Tibet, Nepal and few other countries and I knew that it is true. [*3 points for having used a good strategy, that is, checking background knowledge; used it correctly, and applied it well to make a sound judgment.*]"

Web Site Ranking Assessment

Recall that for this task there were three scores: a score for the actual ranking of the Web sites, a score for the reasons given for ranking a site as most trustworthy, and a score for the reasons given for ranking a site as least trustworthy.

Ranking score. The ordinal regression model investigating effects of instruction and preassessment scores on postassessment scores had a coefficient of .259 for instruction in the framework. The positive coefficient for the independent variable indicates that instruction in the WWWDOT framework increased the probability of making the correct judgment on which Web site was trustworthy and which was not. However, this increased probability was not statistically significant ($p = .272$).

Reasons score. The scores for reasons why one Web site was chosen as the most trustworthy and the other as least trustworthy were significantly correlated ($r = .486$, $p < .001$). Therefore, the two scores were used to create one variable in ANCOVA. There was a significant effect of the intervention on students' reason scores for the Web Site Ranking Task, $F(1, 204) = 56.506$, $p < .001$, $\eta^2 = .07$ (see Table 3 and Fig. 5). Donna, a randomly selected high scorer in the experimental group, stated her
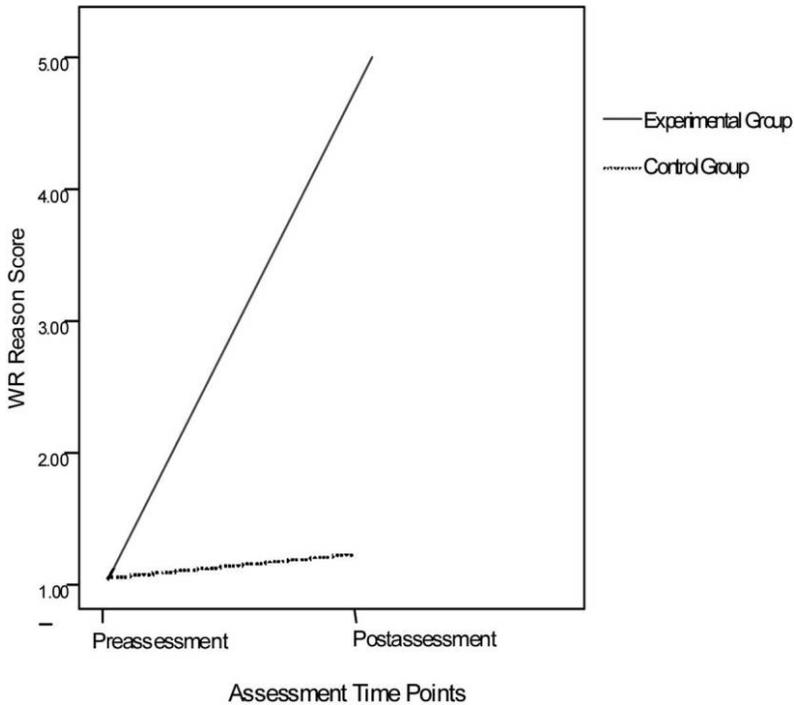
Figure 5. Comparison lines of pre- and postreason scores: Web Site Ranking Task scores.

reasons for trusting one of the Web sites the least as follows: "The author provides almost no information on the main page. The author doesn't even provide their name or when they made it. The author does inform you, but not much. If I were writing a paper on health I would definitely go to a different Web site." While the evaluation and reasoning of this fifth grader is certainly not perfect, it is clearly stronger than that of Trevor, a randomly selected high scorer in the control group: "I think the information on this website is trustworthy because whoever wrote the website wrote many things about the respiratory system, so they must know a lot about it." Trevor stated his reason why he trusted one of the Web sites the least as follows: "[This Web site that I trust the least] had few info, only links to other websites. The writer must know little about the respiratory system."

Discussion

The findings suggest that only four 30-minute sessions of instruction in the WWWDOT framework changed fourth- and fifth-grade students' views about the credibility of information on the Internet. In contrast to the uncritical stance toward the Internet well documented in the literature (e.g., Hoffman et al., 2003; Kafai & Bates, 1997; Killi et al., 2008; Kuiper et al., 2005; Lorenzen, 2001; New Literacies Research Team & Internet Reading Research Group, 2006; Wallace et al., 2000), students who experienced the WWWDOT lessons came to realize that information on the Internet is not always accurate or true. Arguably, this awareness is a fundamental undergirding for anything the students might learn about the evaluation of Web sites as sources of information. As such, we believe this is especially appropriate and important to develop in elementary-age students.

Instruction in the framework also improved students' Web site evaluation skills, again in contrast to the typical state of affairs for U.S. students (e.g., New Literacies Research Team & Internet Reading Research Group, 2006; Wallace et al., 2000). After receiving the instruction, students could evaluate Web sites on multiple dimensions. However, students' overall judgment of the credibility of Web sites as trustworthy or not trustworthy and their ability to rank Web sites by relative trustworthiness were not improved at a level of statistical significance. More specifically, we can draw the following conclusions.

First, participants who received instruction in the WWWDOT framework outperformed participants who did not receive the instruction in critically evaluating Web sites on various dimensions. This finding was confirmed with three assessments including the questionnaire, the Single Web Site Evaluation Task (reason scores), and the Web Site Ranking Task (reason scores). After receiving the instruction, students looked at Web sites with more depth. Instruction helped students realize the importance of evaluating a Web site on dimensions such as authorship, when it was created or updated, why it was created, and its organization. While reading Web sites, students who received instruction in the WWWDOT framework applied what they learned and noticed aspects that allowed them to judge the trustworthiness of the information presented.

Second, although instruction in the framework enabled participants to point out trustworthy and untrustworthy aspects of a Web site, participants did not show improvement at a level of statistical significance in their overall judgment of a site's trustworthiness. One possible reason for this is that instruction made them overly critical (recall that "no I don't trust it" resulted in a score of 0 for both forms of the Single Web Site Task). Another explanation is that students know what to do but lack the relevant background knowledge to do it for those particular sites. Another is that students were not able to synthesize information they collected about the various dimensions of the Web site's credibility to make a sound judgment. As shown in the analysis of the scores on the reason part of the Single Web Site Evaluation Task, students were able to gather information about many aspects of a Web site that would inform a judgment about whether it is trustworthy or not. That might be just the first step, and synthesizing evaluations to form an overall judgment a later step. Additional or different instruction may be needed, or perhaps students simply need more time between pre- and postassessment to practice applying what they learned without additional lessons.

Third, it is not clear whether the experimental group showed improvement in evaluating a Web site with respect to whether the Web site met their needs. The questionnaire data and the data collected through the Single Web Site Evaluation Task and the Web Site Ranking Task suggested different results. The questionnaire data suggested that the experimental group did not show improvement in their report of whether they are inclined to, and can, evaluate whether a Web site meets their needs. However, experimental group students' responses to the Single Web Site Evaluation Task and Web Site Ranking Task showed that some did include their needs in evaluating Web sites after they received instruction. Perhaps the difference is due to the fact that the questionnaire items were decontextualized, whereas the other assessments were embedded in scenarios. Finally, we can conclude from this study that WWWDOT did not improve students' self-perceived Web site evaluation skills.

Given the ubiquity of access and use of the Internet, and thus the need for new literacies and critical literacy skills (Burbules, 1997; Lankshear, 1997; Leu, 2002; Leu et al., 2004; Luke, 2000), it is encouraging that only four 30-minute sessions of instruction in the WWWDOT framework had an impact on fourth- and fifth-grade students' attitudes toward Web site evaluation and their attention to different dimensions in Web site evaluation (though we are unable to say which element or elements within those four sessions actually caused the effects observed). While, as noted earlier, a number of scholars have argued that new literacies should be central in classroom instruction (Lankshear & Knobel, 2003; Leu et al., 2004), there is some distance to go before that is a reality. Thus it is noteworthy and important that a brief intervention can have an impact. Of course, it is also important to examine in future research whether and how instruction in WWWDOT can be lengthened, modified, or expanded to have a greater impact.

Limitations

This study is the first in the literature to test the impact of a framework for improving elementary-age students' Web site evaluation skills in a randomized field trial, and it has a number of strengths, such as the use of different types of measures. That said, the study also has several limitations. First, because measures of students' Web site evaluation skills did not previously exist, the researchers created all measures used in this study. Although the procedures for creating these measures were extensive, and the measures proved reliable and analyzable, there is nonetheless space for more elaborate assessment development and use of these further developed assessments in testing the impact of this intervention and others.

Second, students' ranking scores might be affected by the readability level of each Web site, and this factor was not entirely controlled. According to the SMOG Reading Level Calculator, the Web sites had appropriate readability. However, it is possible that there are difficult linguistic structures and vocabulary in some parts of the Web sites, especially those used for the Web Site Ranking Task, that were not well captured by the SMOG. Moreover, the SMOG was not designed to measure the readability of Web sites, and Web site readability could be a different construct than printed-text readability.

Third, the matched-pair design in this study was only at the class level and favored district and school demographic characteristics over other factors. Matching at the student level, and matching on a greater range of factors, such as teachers' graduate degrees, would have made for a stronger design; however, this was not possible due to constraints on the sample size and the sample pool.

Fourth, we must be cautious about generalizing the findings to other settings. Even though the participants in this study came from different backgrounds, the sample size of 12 classes is relatively small, and some groups, such as English language learners, were not well represented. Moreover, this study only tested the framework with fourth- and fifth-grade students. The results might not hold with other age groups.

Future Research

This study was an important first step in testing a framework for improving students' Web site evaluation skills. Clearly, additional trials are called for to add to the

sparse empirical base on this topic. First, the effect of instruction in the WWWDOT framework, as well as expanded or alternative frameworks, should be examined with students in other grade levels, settings, and samples. Second, studies should examine how students apply or do not apply what they learn from the WWWDOT framework to their everyday Internet reading at home or at school. Third, research should deepen our understanding of the informational synthesis process with respect to critical evaluation of Web sites. Studies should investigate how good elementary-age Web site evaluators evaluate Web sites, synthesize information, and make sound judgments, and how they developed their evaluation ability (see Zhang & Duke [2010] for some data along these lines). Fourth, studies should examine the longer-term effects of instruction in the WWWDOT framework. Do students taught this framework demonstrate differences in their view of Web site credibility and their Web site evaluation skills months after instruction? What kind of follow-up, if any, is necessary? Finally, it would be interesting to examine whether this instruction transfers to evaluation of print text or texts more multimedia in nature than those examined here.

Notes

1. The procedure by which these examples were selected is as follows: First, the performance level (e.g., average level) for comparison was decided and the IDs of students at that performance level in each condition group were listed. Second, from the IDs of students of the average performance level in each group, one ID was randomly selected for each group and that student's writing example was pulled.

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