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Critical Evaluation of Scientific Websites by High School Students

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ABSTRACT

This study describes an instructional intervention in which high school biology students learned to develop criteria for critically evaluating scientific Websites and scientific information contained in them. Results indicated that the process of learning to critically evaluate Websites was what was most valuable to them. Students' lists of criteria for critically evaluating Websites were more extensive after instruction. Furthermore, the majority of students reported learning something new, indicated that they would spend more time evaluating scientific information on Websites, and reported increased confidence in their ability to evaluate scientific information on the Web.

INTRODUCTION

The question of the validity or credibility of information on the World Wide Web is a growing concern to educators, parents, students, and others. As students are encouraged to engage in project-based research, more of their information is from the Web where anyone can publish anything at any time. Teachers frequently assume that students have learned how to critically evaluate Website information sources and that it is the responsibility of other teachers (most often English teachers) to have covered this topic (Nguyen 2000). This often inaccurate assumption increases the need for students to learn to evaluate information sources.
and for teachers to learn to carry out instruction that effectively facilitates this process in all content areas.

This concern is especially important in the area of science learning because students as beginning scientific researchers, or at the very least, lifelong consumers of scientific information, must be able to adequately assess claims and make judgments about scientific information in general, not just information on the World Wide Web. This aspect of scientific literacy is deemed to be essential by the American Association for the Advancement of Science in *Benchmark for Science Literacy* (1993):

> "In everyday life, people are bombarded with claims—claims about products, about how nature or the social systems or devices work, about their health and welfare, about what happened in the past and what will occur in the future. These claims are put forth by experts (including scientists) and nonexperts (including scientists), by honest people and charlatans. In response to this barrage, trying to separate sense from nonsense, knowledge helps." (p. 298)

Learning to critically assess information is important in part because of the proliferation of non-referenced material on the Internet. It is also imperative due to the movement away from single-textbook-based science teaching where judgments of accuracy of information were outside the purview of teachers and students, and in the hands of textbook writers and editors. Accuracy judgments have been placed into the hands of individual students and teachers who are very likely to have not experienced instruction in how to effectively make those judgements. Therefore, in this paper we examine work that provides a needed foundational research base for students’ critical evaluation of Web-based scientific information, and we describe a study in which we worked with high school students to facilitate their development of individual and group criteria to evaluate scientific information on Websites.

Prior work in this area includes research that develops criteria for evaluating Websites or, frequently, software and/or multimedia in general (e.g., Chen 1995, Sherry 1998, Nguyen 2000). Chen (1995) for example, provided an interesting approach that evaluated the pedagogical techniques employed by software, according to learning theories. Sherry (1998) described an exercise in which she had students develop a "multimedia matrix" for developing their own multimedia. Although this approach was employed at the graduate level, her suggestions for student personalization of the matrix could well be adapted for students at other levels evaluating Websites.

An innovative approach was developed by Nguyen (2000) where high school students in three different subject areas, including science, created an
Critical Evaluation of Scientific Websites by High School Students

This research examines the credibility and reliability of scientific websites provided by high school students. The evaluation tool called OASIS was used to assess the accuracy and trustworthiness of the websites. OASIS is a valuation tool that provides a framework for evaluating the credibility of scientific information. The study found that websites containing multimedia resources, such as videos, images, and interactive elements, were more credible than those without. These findings are supported by other research, which indicates that multimedia enhances learning outcomes.

In conclusion, scientific websites can be valuable educational tools. However, students need to be taught how to critically evaluate the credibility of information presented on these sites. Teachers and educators should incorporate critical thinking skills into their teaching. This will help students understand the importance of evaluating sources and selecting reliable information for their studies.
authors were interested in providing students with the opportunity to examine and further develop their own criteria for the assessing information from the Web. It was hoped that students would understand the importance of critically evaluating scientific Websites and the information contained in them. In the rest of the paper, we explain how the process was facilitated and evaluated, and discuss the impact of the process on the students.

2. METHOD

2.1 Participants

Participants were students in two senior biology classes at the University of Hawaii Laboratory School. The students are from diverse ethnic, ability, and socioeconomic backgrounds reflective of Hawaii’s population. The ethnic breakdown consists of approximately 38% mixed ethnicity (including part-Hawaiian), 18% Caucasian, 18% Filipino, 18% Japanese and 10% other (including Asian, Pacific Islanders, African-American). In the first class, participants included 10 boys and 10 girls. In the second class, participants included 9 boys and 10 girls.

2.2 Procedure and materials

This workshop on scientific Website evaluation took place in the students’ regular biology classes, over the course of four days. The three authors, their regular biology instructor (a scientist and curriculum developer), an educational technology specialist, and an educational psychology professor co-facilitated the workshop. Below, we briefly describe the sequence of events and the materials that were used.

On the first day, students answered two pretest questions that required that they list and describe what they consider first, when deciding to use a Website in general, and, secondly, what they consider when evaluating the scientific information on the Website. They ranked the items in their lists. Then, the educational technology specialist provided a brief description of the terms Internet, World Wide Web, Websites, and individual Web pages. She also provided a general introduction to three areas to consider when evaluating Websites and the scientific information on them: credibility of authors and institutions, validity or accuracy of the information contained in Websites, and the presentation aspects or organization of the Website and its information (e.g., layout, graphics). This characterization of Websites in
derived from Farah (1995) and Rader (1998) and adapted in the research of Neven (2000).

On the second day, students engaged in actual Website evaluations to gain experience in the critical evaluation process. They carried out written evaluations of two Websites containing scientific information about a disease. One was accurate and credible while the other contained deliberate errors and invalid information. These websites were created for educational purposes of this sort. Students compared the Websites in terms of reliability, credibility, and presentation. Then, students evaluated a third Website containing information about frogs and learning. They listed pros and cons of using the Website to look for scientific information in general, and for using information from the Website for their scientific research or scientific research papers.

On the third day, teams of 5 students developed collaborative lists containing characteristics that they determined would be important for themselves or other students like them to use in evaluating scientific information on Websites. In the second part of the class, their teacher and the educational psychology professor facilitated the development of whole-class lists on the board, via whole-class discussion of characteristics from the collaborative lists. The purpose of this activity was to facilitate students' deeper processing and refinement of their criteria.

On the fourth day, summative evaluation took place. First, using the same two questions that were used in the pretest, students created individual lists for evaluating scientific Websites generally then for determining whether to use scientific information from Websites. These items were ranked. The instructions were the same as those given for the pretest. Next, students filled out follow-up questionnaires consisting of 12 items assessing whether their views of how to evaluate scientific information on Websites had changed and how, whether their confidence in their abilities to evaluate Websites had improved, what the most important things were that they had learned, and their general suggestions and comments regarding the activities.

3. RESULTS AND DISCUSSION

3.1 Did criteria for evaluating change?

The items from the pre- and post-Website evaluation program student-generated lists used to evaluate scientific Websites and the science information on Websites were categorized by the experimenters into the categories validity, credibility, or presentation. The pre- and post-education
program data for the three categories were then summarised as percent of total (Tables 1 and 2) and means (Figures 1 and 2).

Table 1. The number (in parentheses) of student-generated items used to evaluate scientific websites generally categorised as validity, credibility, or presentation and expressed as percent pre-education program percent of totals and change in percent of totals.

<table>
<thead>
<tr>
<th></th>
<th>Validity</th>
<th>Credibility</th>
<th>Presentation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>51% (80)</td>
<td>40% (63)</td>
<td>9% (15)</td>
<td>100% (158)</td>
</tr>
<tr>
<td>Post</td>
<td>45% (116)</td>
<td>32% (83)</td>
<td>23% (59)</td>
<td>100% (258)</td>
</tr>
<tr>
<td>Change</td>
<td>-6% (38)</td>
<td>-8% (45)</td>
<td>+14% (44)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. The number (in parentheses) of student-generated items used to evaluate scientific information on websites categorised as validity, credibility, or presentation and expressed as percent of totals and change in percent of totals.

<table>
<thead>
<tr>
<th></th>
<th>Validity</th>
<th>Credibility</th>
<th>Presentation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>63% (79)</td>
<td>27% (33)</td>
<td>10% (10)</td>
<td>100% (158)</td>
</tr>
<tr>
<td>Post</td>
<td>52% (130)</td>
<td>27% (69)</td>
<td>21% (55)</td>
<td>100% (258)</td>
</tr>
<tr>
<td>Change</td>
<td>-11% (57)</td>
<td>-6% (30)</td>
<td>-11% (45)</td>
<td></td>
</tr>
</tbody>
</table>

As can be seen in Tables 1 and 2, for both the website and information on the website, the percent of total was the highest for validity-related items, followed by credibility-related items and then presentation-related items. Analyses of variance indicated that when the number of items for the three categories were combined, students generated significantly more evaluative items for both scientific websites and for scientific information on websites evaluated after participation in the website evaluation program [Pre vs Post mean ± S.E.M.: 1.32 ± 0.121 vs 2.15 ± 0.168, F(1,119) = 19.7, p < 0.000003; 1.03 ± 0.09 vs 2.17 ± 0.299, F(1,119) = 37.0, p < 0.00000002, respectively]. Although the number of student-generated items appeared to be greater following participation in the website evaluation programs, the percent of totals changed in the positive direction only for presentation-related items (Tables 1 and 2). This indicated that the web evaluation program may have had the most impact on student awareness of the presentation aspects of scientific websites and information evaluation.

Figures 1 and 2 present the mean number of student-generated items for the three categories before (Pre) and after (Post) the web evaluation program.
For both scientific Websites (Figure 1) and scientific information found on Websites (Figure 2), the number of student-generated items was significantly higher following the Website evaluation program for validity ($t_{(df=39)}=-2.05, p=0.05$ and $t_{(df=39)}=-3.29, p=0.003$, respectively) and presentation ($t_{(df=39)}=-4.70, p=0.0001$ and $t_{(df=39)}=-4.51, p=0.0001$, respectively). The number of student-generated credibility-related items...
following the Website evaluation program was significantly greater for scientific information found on Websites than before the program, $t(df=39)=3.40, p=0.002$. However, the Website evaluation program did not significantly effect the number of student-generated credibility-relating items used for evaluating scientific Websites [see Figure 1, $t(df=39)=-1.90, p=0.05$].

3.2 Had students’ evaluation processes changed?

On a scale ranging from ‘not at all’ (0mm) to ‘moderately’ (7.4 mm) to ‘very much’ (14.8mm) on the post-program evaluation questionnaire, students indicated that the Website evaluation program moderately (mean=7.94 mm) changed their views of how they should evaluate scientific information on a Website. According to 80% of the students, this change in view was due to the process of creating and discoursing their lists of items; 20% attributed the change in view to the actual lists that they created. One student wrote, "I think that what changed my views was the exercise in general, bringing attention to the problem of false Websites." Ninety-percent of the students indicated that, in the future, they will spend more time evaluating scientific Websites before using the information.

The majority of students (75%) involved in the Website evaluation program claimed they had learned something new about evaluating scientific information on Websites. Comments from students about specific ways their views of how to evaluate scientific information changed included validity, credibility, and presentation characteristics. For example, "There are phony Websites and checking a Website is important when researching a specific topic, especially when you want to use the information as a source for your scientific paper," "I learned to always check an author’s credentials before using his/her information," and "The way a site looks. Is it organized, readable, eye-catching, pictures, diagrams, etc?"

Students also indicated that they realised that presentation in itself does not justify believing the information presented on a Website: "A nice looking Website does not mean it’s credible. There are many more ways of determining if a Website is good enough for use or consideration. My view is that evaluating scientific information is a little more important than I thought," and "Read carefully, don’t automatically assume information is accurate if presented nicely.”

When students were asked to rate the importance of the process of learning to critically evaluate information on scientific Websites (1=not at all important, 2=of little importance, 3=important, 4=very important, and 5=absolutely necessary), the mean rank (3.3) indicated they considered the process of learning to be between important and very important. Student
CONCLUSION

Clearly, educational activities facilitating students’ critical evaluation of scientific information on Websites and the Websites themselves can be effective. In the present research, students indicated that the process of learning to critically evaluate Websites was what was most valuable to them. Additionally, students’ lists of criteria for critically evaluating Websites were more extensive after instruction, and included more presentation-related criteria. The majority of students in this study reported learning something new, agreed that they would spend more time evaluating scientific information on Websites, and reported that their confidence in their ability to evaluate scientific information on the Web had increased.

The ability to critically evaluate scientific information, such as the information on Websites, is consistent with the American Association for the Advancement of Science (1993) description of scientific literacy, and is necessary as more and more scientific information is disseminated on the World Wide Web and referenced by students for research projects. This is, in turn, important as these students disseminate their own scientific research reports and contribute to scientific and educational databases on the Web. As future directions for educational programs and/or research endeavours, we recommend working with students at all levels and in all content areas to facilitate their critical Website and information evaluation skills.

REFERENCES


Dr. Marie Iding is an Associate Professor in the Educational Psychology Department at the University of Hawaii. Her research interests include scientific visualization and text processing with multimedia systems. She teaches courses in learning and cognition.

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