"Use and Misuse of Internet Search Engines by High School Chemistry Students"

Martha Gwen Sibert
Roanoke Valley Governor's School
Roanoke, VA
gsibert@rvgs.k12.va.us

Abstract

This paper examines the use of Internet search engines such as Google and Yahoo by high school chemistry students. Personal experience by the author indicates that too many high school students believe that if something is posted on a website it is true and factual. The paper includes examples of excellent references found using search engines as well as examples of completely erroneous or farfetched information found using these same engines. Some ways of teaching students how to discern "truth" from "fiction" will be presented, as well how they can be taught to tell the difference between information that is simply "opinion" and that which is based on scholarly work. Also, a comparison of the links some of the more popular search engines provide for a variety of chemistry queries are included.

Introduction:

Searching for information on the Internet can be both easy and difficult at the same time. It is an important skill that high school students need to develop as they prepare for college and for the world of work afterwards. This paper is the result of my own experiences and from conversations with other teachers who shake their heads and wonder aloud about how to get their students to evaluate the information on the millions of websites on the Internet **BEFORE** they use it. I decided that I would spend some time this summer to try to develop suitable guidelines and requirements to help my students at the Roanoke Valley Governor's School as they use Internet search engines, not only for my class but for other classes as well.

The Roanoke Valley Governor's School for Science and Technology (RVGS) is a regional school for gifted and highly achieving students that is supported by seven area school systems with a total of thirteen high schools. The schools range from very small (about 300 total students grades 9-12) to relatively large (about 1900 students grades 9-12). Enrollment during the school year 2003-2004 was approximately 250 students in grades 9-12. Some of the students live on farms and help with chores before they leave for an hour-long ride on a school bus to get to RVGS while others live in the affluent suburban or urban neighborhoods and drive to school and still others live in subsidized housing projects and ride local school buses. Students are selected to attend RVGS by their home school system although a common application form is used by all systems. Also, students must be enrolled in a public high school in order to be eligible to attend RVGS. The majority of students who take the second-year chemistry course are sophomores (one half to two-thirds) with the rest juniors and a few seniors. Again, all of the students have been identified a gifted in science and/or math. More information about the Roanoke Valley Governor's School can be found at www.rvgs.k12.va.us.

Most of the material for the second-year chemistry course (formerly called Advanced Chemical Topics) can be found at www.chem.vt.edu/RVGS/RVGS-home.html. For a variety of reasons, for the school year 2004-2005 the course will be changed to Advanced Placement Chemistry.

Last year, all of the students in my three second-year chemistry classes had a computer at home and access to the Internet. This has been the case for several years, so over the past four or five years I have given more and more online homework assignments and projects that require the use of Internet search engines such as Google and Yahoo. It is my observation that far too many high school students are of the opinion that if something is posted on a website, any website, then it must be true fact. Every year students come across websites such as http://www.malepregnancy.com/ andhttp://www.dhmo.org/ and actually believe that these are serious sites. Granted that the majority of my students are not fooled by something so blatantly "off the wall" as the first link, I have had information from the second one turned in as being really true.

The main online homework assignment is a weekly assignment that I call "Questions of the Week" or "QOTW" (seehttp://www.chem.vt.edu/RVGS/ACT/Questions_03.html) and this is where I find the most "misuse" of search engines. Each week two to five questions usually related to the unit of study at the time are posted on QOTW page. Specific directions are given at the top of the page regarding what kind of information is needed, how to format the page and how to save the file. These questions are posted by the Sunday before their date and the answers are due via email by the following Monday evening by midnight. For example, QOTW for the week of August 30, 2004 were due by midnight on September 6.

It is these assignments that present the greatest challenge to many of my students. First, even though I take class time to go over the questions the Monday they are assigned and often give hints as to what would be appropriate phrases to put into a search engine to get good links, some students either do not pay attention in class or do not take advantage of the help offered. I always check to make sure that the answers for each QOTW can be found on at least two websites. I also tell them that if after 20 minutes of searching without success, then they should email or instant message me for help. Some students, however, spend far too long searching for the answers to the questions and instead of emailing me for help, find a site where it looks like something related to the question and copy whole paragraphs and paste them into the document. These sometimes include references to figures and/or tables and graphs that are on the website, but were not included in the copy and paste. When I read what was turned in I can tell that there was no paying attention to what was put there.

Examples:

One example of a question where some students found erroneous information was the following question about Linus Pauling from the Feb 23, 2004 assignment that was posted during the week of his birthday anniversary.

> **Question:** What did Linus Pauling do that earned him the high honor of being awarded the Nobel Prize in chemistry? What influence did this work have on later developments in chemistry?
>
> > **Answer:** Linus Pauling was awarded the Nobel Prize in chemistry for his research into the nature of the chemical bonds and its applications to the elucidation of the structure of complex substances. (http://www.nobel.se/chemistry/laureates/1954/index.html)
> >
> > **Answer:** Linus Pauling won the Nobel Prize for Chemistry in 1954. He was awarded the prize for his work on genetic influences in relation to the atomic structure of proteins in hemoglobin. He discovered that genetic defect is the

cause for sickle cell anemia. His work was the basis for the study of human genes and diseases. (http://www.wic.org/bio/lpauling.htm)

The first answer comes from the Nobel Prize website and is the citation that accompanied his Nobel Prize and the second answer, which is wrong, is from the website of an organization called the Women's International Center. Of course, the information itself isn't actually wrong as Pauling did do these things, but they don't represent the overall work for which he received this prize.

Other examples that illustrate both good answers and poor answers along with the links for the source of the answers can be found at this link.

Search Engines:

Even though there are many search engines available today, my preference is to use Google to look for information and for images on the Internet. When I typed in "evaluating online information" in the Google window it gave results showing **2,060,000 links**! After spending several hours just checking the first four pages of links, I decided that instead of "reinventing the wheel" I would put together a document with an overall summary of what is the overwhelming consensus of all the sites as to what determines reputable information, along with links to a dozen or so of the more thorough sites that then go into detail about evaluation of a website. The same phrase ("evaluating online information") was also used in Altavista with **2,170,000**results, Yahoo with 2,130,000 results, HotBot with 458,048 results, and WebCrawler with only **81 results**. With few exceptions, the same sites showed up in all the results, but usually in a different order.

The first link listed on Google was http://www.library.cornell.edu/olinuris/ref/research/webeval.html (Revised 24 February 2004), however it was the sixth link on Altivista and seventh on WebCrawler.

These websites with information on evaluating web pages are in agreement as to how to help students decide when a website has correct or erroneous information about a topic and also how they can determine the bias of an author regarding an issue. Some are very thorough and represent considerable detail whereas others are much briefer and simply give an overview of the basic guidelines to use. The following website is representative of the websites that I have listed at the end of this paper.

Evaluating Web Pages: Techniques to Apply & Questions to Ask
UC Berkeley - Teaching Library Internet Workshops by Joe Barker (Last update 27July2004)
http://www.lib.berkeley.edu/TeachingLib/Guides/Internet/Evaluate.html

1. What can the URL tell you?
   First there are questions to ask yourself…what is the web address? Is is a personal name or a commercial ISP? What is the domain name? Is it educational, nonprofit, commercial or government? Who is the publisher of the page?
2. Scan the perimeter of the page, looking for answers to these questions:
   Does it give information about the author(s) or group that produced it? Can you get to this information? What are the credential of the author, agency or group? What is the date of this page? How current is it and has it been kept up-to-date?
3. Look for indicators of quality information:
   Are references or sources of the information given? Who published the page? Are there links to other pages, and do these links work? Is information regarding copyright and permission about using the material provided? Are there links to other sources of information on the subject. Is it apparent that this site is biased? Are links to other viewpoints provided?
4. What do others say?
   Check to see if the site is linked from other sites, and what kind of sites they are. What information can you find out about the reputation of the author(s)?
5. Does it all add up?
   Ask why this page was put on the Internet. What is it's purpose? What is the intentions of the author(s)? Is it to inform, give facts, explain, persuade, sell, entice, share, or disclose? Is it serious or is satire or parody? Would I find better information using library resources or online web-based indexes available at a library?

Joe Barker in his reply to my request for permission to use his material in this paper and with my students says;
"You are welcome to use or link to the materials as you outline. What you are doing is very useful, and will help the students later on. We experience similar ignorance about evaluation of web resources among UC students. I think, really, that none of us learned much about evaluation in the old print-only world, and perhaps the need was so much less then. Publishers were believed to vett the content. We learned what to think of the publication, and not to trust certain ones. On the web, all appears "published" and students don't know how much greater the burden falls on them to evaluate."

Rubrics/Questionnaires:

One of several examples of questionnaires that can be used to evaluate a webpage is provided at:
http://jhss.wrdsb.on.ca/library/html/evaluate/evalinfo.htm (This page was last updated Tuesday May 9, 1995.)

Normally I wouldn't use information from a site this old without evidence of more recent updates, but these questions are still appropriate and cover all of the areas discussed by those pages that describe how to go about evaluating a site.

Evaluating Information
Some questions to help you judge Online Information

1. Your Knowledge
   o How does this new information compare to what you already know?
   o How does it change what you know?
2. Authority
   o Who is providing the information?
   o Where did their information come from?
   o Do they provide evidence or examples to support their points?
   o Why do you think they are providing this information?
3. Time
   o How old is the information?
   o Does it include recent information?
4. Scope
   o How much information is given?
   o How broad is the topic area?
   o How in-depth is the information?

5. Form
   o In what package is the information being presented?
   o Is it a WWW or gopher document, a text file, a newsgroup posting, or an email message?
   o Is it in text, image, and/or sound form?
6. Clarity
   o Is the information clearly presented?
   o Is it well organized?
   o Is the site user friendly?
7. Recommendations
   o Have people who you respect (friends, teachers, librarians, or parents, etc.) recommended this site as a good source of information?
8. Validity
   o How true do you think the information is?
   o What makes you think so?
9. Importance
   o Is this important information?
   o If it is, why is it important?

Other sites with evaluation rubrics are:

- Web Evaluation for Secondary Grades
  http://www.siec.k12.in.us/~west/edu/rubric3.htm
- Web Page Evaluation Checklist
  http://www.lib.berkeley.edu/TeachingLib/Guides/Internet/EvalForm_General_Barker.pdf
- 2Learn.ca 'NetCheck Website Evaluation Form for Grades 10-12 Students
  http://www.2learn.ca/evaluating/div4netscheck2.html
- WWW CYBERGUIDE RATINGS FOR CONTENT EVALUATION
  http://www.cyberbee.com/content.pdf (c)Karen McLachlan, 7/31/2002
- Checklist for Evaluating Web Resources
  http://library.usm.maine.edu/research/researchguides/webevaluating.html Last Update: 01.2004
- Evaluation Rubrics for Websites
  http://www.siec.k12.in.us/~west/online/eval.htm last updated March 23, 1998 ** pages created June 29, 1997

Some sites serve as lists of links to other pages with information about website evaluation. Five of these sites are:

- Kathy Schrock's Guide for Educators
  http://school.discovery.com/schrockguide/eval.html (c)1995-2004 Kathleen Schrock.
- Websites Covering the Evaluation of Online Information
  http://www.tlc.murdoch.edu.au/eddev/eddesign/onlinelearning/criticaleval/websites.html (c) 2004 (c) 2004 Murdoch University
- Locating and Evaluating Online Information
  http://www.midgefrazel.net/search.html Page created: 3/21/97 Last modified: 1/30/03
- EVALUATING WEB PAGES: LINKS TO EXAMPLES OF VARIOUS CONCEPTS
  http://muse.widener.edu/Wolfgram-Memorial-Library/webevaluation/examples.htm Copyright: J. Alexander & M. A. Tate: 1996-1999
- Evaluation of information sources
  http://www.vuw.ac.nz/staff/alastair_smith/evaln/evaln.htm Last modified 23 October 2003
  This page contains pointers to criteria for evaluating information resources, particularly those on the Internet. It is intended to be particularly useful to librarians and others who are selecting sites to include in an information resource guide, or informing users as to the qualities they should use in evaluating Internet information. Feedback and suggestions of other sites for inclusion are welcomed by the site maintainer, Alastair Smith.

Other websites that offer a wide range of information on evaluating websites are the following:

- The Good, the Bad, the Ugly:
  http://lib.nmsu.edu/instruction/eval.html Last updated on 08/18/2004 21:05:47
- An Educators' Guide to Credibility and Web Evaluation (white paper)
  http://lrs.ed.uiuc.edu/wp/credibility/index.html Date Last Modified: 7/01/2002
- Elementary CCs for evaluating internet sites
  http://www.neutralbay-p.schools.nsw.edu.au/library/infoeval.htm updated 9 March 2003
- Ten C's For Evaluating Internet Sources
  http://www.uwec.edu/Library/Guides/tencs.html Last modified: June 29, 2003
- Evaluating Internet-based Information: A Goals-based Approach
  http://www2.ncsu.edu/unity/lockers/project/meridian/jun98/feat2-6/feat2-6.html no date
- Evaluating Web Pages: A WebQuest
  http://mciunix.mciu.k12.pa.us/~spjvweb/evalwebteach.html Last updated on December 31, 2001
- A Library Research Guide and Webletter
  http://servercc.oakton.edu/%7Ejmayzel/247/step6.htm no date
- Evaluating Websites: What Makes a Website Good?
  http://www.multcolib.org/homework/webeval.html Created: August 27, 1997; last updated: November 19, 2002
- Five criteria for evaluating Web pages
  http://www.library.cornell.edu/olinuris/ref/webcrit.html Converted to HTML by Paul McMillin, September 18, 1998
- Evaluating Science WWW Resources
  http://www.ncsu.edu/imse/3/evalweb.htm" no date
- Teaching Internet Research Skills
  http://www.virtualchase.com/researchskills/ Created: 14 July 2000, Revised: 15 March 2002
- The Web - Teach Zack to Think
  http://www.anovember.com/articles/zack.html September 1998
- Thinking Critically about World Wide Web Resources
  http://www.library.ucla.edu/libraries/college/help/critical/index.htm Updated September 6, 2000
- Untangling the Web: Tip Sheet
  http://www.closeup.org/ncss-tip.htm Last Updated: November 20, 1997
- Assessing the Validity of Online Information
  http://tlt.suny.edu/evaluation.htm updated - 06/28/04
- Here are eight ways of checking information on web sites
  http://www.quick.org.uk/menu.htm Last updated 15th May 2000
- Evaluating Web Resources
  http://muse.widener.edu/Wolfgram-Memorial-Library/webevaluation/webeval.htm Copyright Jan Alexander & Marsha Tate, 1996-1999
- But - I found it on the Internet!
  http://csmonitor.com/cgi-bin/durableRedirect.pl?/durable/2000/04/25/p16s1.htm from the April 25, 2000 edition Christian Science Monitor
- Evaluating Internet Research Sources:
  http://www.virtualsalt.com/evalu8it.htm Version Date: November 17, 1997
- Fact, Fiction, or Opinion? Evaluating Online Information
  http://www.education-world.com/a_curr/curr194.shtml Updated 10/31/2003
- Smith, Alastair G. "Testing the Surf: Criteria for Evaluating Internet Information Resources." The Public-Access Computer Systems Review 8, no. 3 (1997). (Refereed Article)
  http://info.lib.uh.edu/pr/v8/n3/smit8n3.html
- Evaluating Quality on the Net
  http://www.hopetillman.com/findqual.html date last touched: 28 March 2003
- Five criteria for evaluating Web pages
  http://www.library.cornell.edu/olinuris/ref/webcrit.html Revised 24 February 2004
- Evaluating Websites: Criteria and Tools
  http://www.library.cornell.edu/olinuris/ref/research/webeval.html Revised 24 February 2004
- Why we need to evaluate what we find on the Internet
  http://www.lib.purdue.edu/itd/techman/eval.html Originally published 1996. Cosmetic update 2001. Minor nudge, 05/2004.
- Evaluating Information Found on the Internet
  http://www.library.jhu.edu/elp/useit/evaluate/ Last Updated 06/5/2002
- Evaluating Online Information
  http://www.ncrel.org/sdrs/areas/issues/content/cntareas/reading/li3lk20.htm

- Untangling the Web: Guidelines for Researching on the World Wide Web
  http://www.closeup.org/untangle.htm Nov 22, 1997
- Evaluating Web Sites and Internet Resources
  http://library.csumb.edu/instruction/howto/eval.php (c)2004 Last updated: August 20, 2002

Summary:

"But, I found it on the Internet!" has taken the place of "But, I read it in the newspaper!" or "But, I saw it on the TV!" as the excuse students use when they turn in erroneous information in an assignment, project or paper. Anyone can publish just about anything he or she desires without any kind of peer review or publisher oversight, so it has become even more important that students be taught how to discern "truth" from "fiction" as well as how to tell the difference between information that is simply "opinion" and that which is based on scholarly work. Today there is a wealth of very good information available on the Internet. Students must learn how to look for scholarly, reputable, accurate and unbiased information. The presence of online journals such as **The Journal of Chemical Education** and **Chemical and Engineering News** are examples of sources of this later kind of information. Teachers must emphasize how important good searching skills are, and they must offer ways of evaulating websites.

The websites listed above represent just a few of the many sites with information on evaluating online information. They represent a wide range of information, from simple "Here are questions you should ask regarding a website" to detailed discussions with examples of uses of really bad information.

The topic of evaluating online information will be introduced to the AP Chemistry classes a few weeks after school starts and after a few of the Questions of the Week assignments have been completed. I believe that the students will better appreciate the need for the carefull evaluation of websites after they have had the experience of looking at a variety of sites to get information for their assignments. Feedback from student use of three of the evaluation rubrics will be available in time for the discussion period for this paper.