Using the Internet to Enhance Biology Education: Suggestions for the Novice

Marion Field Fass
Biology Department
Beloit College
Beloit, WI 53511

Abstract: This paper provides examples of Internet resources, specifically email and world-wide web uses, in undergraduate biology courses. Educators find both challenges and opportunities as new technological tools become available. Both pitfalls and valuable practices for students in computer-enhanced courses are emphasized. Faculty who wish to learn more about using email and web resources in their courses will find examples of activities and accessible web pages that reflect the author’s approach to solving some of the dilemmas of the internet’s unrestricted worldwide communication and access. The Internet offers “an infinitely expanding classroom” for perceptive and prepared faculty and students.

Keywords: internet, web pages, email, listserv, educational technology, teaching strategies, biology education, emerging diseases, pedagogy

New technologies bring with them opportunities and challenges. Educators are faced with the challenge of using email and the Internet, as well as other computer technologies to improve pedagogy. Email and the Internet provide increased communication and access to information, but additionally can provide opportunities to vastly expand the scope of the classroom and the textbook. The challenge for educators is to explore how can we use these tools to open the educational process in our classrooms and labs.

More and more students arrive on campus with computers of their own and with some experience on the Internet. In 1997, sixty-percent of new Beloit College students arrived with computers. Students have learned word processing at high school and may have subscribed to America on Line or another Web browser. Some have skills that far surpass those of most of their professors, while others are only typists.

While many of the students arrive on our campuses with experience playing or shopping on the Internet, few have used it for serious research. As they begin to do research and probe primary sources at college, we face the challenge of integrating their web skills and their research skills into a coherent approach.

At the same time faculty are exploring the potential of the Internet to enhance student learning. Campuses are linked to the Internet, but often faculty are left alone to discover the best use of these resources. The aim of this article is to provide teachers with an introduction to the potentials and the problems of using the Internet in the college biology classroom. We will explore the uses of email, the potentials and pitfalls of “library research” and then look at some of the potential new areas for use of technology in the classroom and the lab.

EMAIL. Email is the first introduction to electronic communication, and one which most faculty have adopted. Email can be used to increase communication with students on campus and off, and to extend the reach of classroom discussion. The simplest use of email is to construct a class list and use it as a bulletin board, to modify assignments and clarify questions raised in class. The email software Eudora allows users to set up a “Nickname” which can send mail to all students listed. Through email communications, faculty can provide students with guidance on reading difficult materials, such as journal articles or help structure study.

The email message below was sent to guide non-majors in reading an article by Joshua Lederberg, “Infectious Disease as an Evolutionary Paradigm” which was published in Emerging Infectious Diseases, Spring 1998.

Email can also serve as a conduit for student journals about their experiences and about class process and class progress. In this way it can provide students with the chance to give feedback to the instructor and to participate in the construction of course flow. Students comfortably communicating...
Dear Emerging Diseases class-

1) If you didn't get the article, "Infectious Disease as an Evolutionary Paradigm" today, there are copies outside my office in an envelope.

2) This article isn't as hard as it seems. Remember, however, that it was written for health professionals not college students. Read it slowly and remember that evolution is a process of genetic mutation and recombination.

Epitopes are variations in antigens.

On page 421, Lederberg talks about "clonal selection model of immunogenesis". I know that this is a confusing phrase. It refers to the process we discussed in class, that when T cells or B cells encounter an unknown antigen, they recombine genes that produce the different shapes of the Y type receptors, until the random recombination results in a Y type receptor which fits the new antigen. Then this new T cell or B cell is cloned, so that there are lots more cells with receptors that fit. So this is the clonal selection model of immunogenesis. You know more than you thought you did.

In the next paragraph, Lederberg talks about "hemopoetic modifications that thwart the plasmodia"; here he's referring to changes in hemoglobin structure that result in conditions such as sickle cell anemia, which he refers to as modifications in Hemoglobin S. The plasmodium is the parasite which causes malaria. Can we change receptivity to disease by gene therapy? It's an interesting question. Recently scientists discovered a group of men with a mutation in a cytokine producing gene which seems to block HIV from establishing an infection.

Look carefully at tables 3, 4, 5. There's a tremendous amount of information stuffed in these tables. When Lederberg talks about "promiscuous recombination" in table 3, he is referring to the ability of bacteria and viruses and yeasts to exchange bits of genetic information called plasmids across species. This is very important in the exchange of virulence factors; those instructions to the bacteria or virus to produce toxins and enzymes which make the disease more harmful.

OK. I don't want to write as much as Lederberg. Please come to class on Monday with a question about this article...and use a dictionary if you need one.

Have a great weekend.

...with their professor on email can ask for clarification or ask for the classroom pace to be slowed. This process of communication and modification gives students an increased stake in their own learning.

A more sophisticated use of the email is to create a class listserv for discussion. A listserv needs to be set up in consultation with the campus computer service office. In contrast to email, in which all communication is routed through the professor, a listserv becomes the property of all students and is a more egalitarian forum for class discussion. Care of the listserv can be rotated among students in the class. An example of listserv use would be to stimulate discussion about a controversial reading or item in the news; a class on Environmental Biology might discuss recent newspaper articles on the fires in Florida and their environmental impact. Student moderators make sure that the discussion continues by providing probing questions, and keeping responses on track. Students can be required to participate and be evaluated on their comments. A listserv also provides a way to answer questions in large settings so that all students benefit.

**Uses of the Internet and the World Wide Web**

The Internet opens tremendous opportunities for student research from raw data, primary papers and secondary sources. Collections of visual images, movies and animations can expand opportunities for visual learning. The Internet is like a huge library that continually adds new resources, but it also is like the corner newsstands, filled with muckraking and half-truths. One of the challenges for faculty is to guide student use of the Internet to maximize learning and minimize the risks of stumbling down blind alleys, believing iconoclasts, and falling prey to commercial ventures.

**A. Copying.** The Internet provides continually growing sources for research, but may also be abused by students seeking an easy way to fulfill class needs. This section discusses plagiarism as well as creative uses for Internet research.

The most problematic use of the Internet is for access to prewritten term papers. All faculty should be aware of this new resource that supplants fraternity files and locally available commercially written papers. Sites such as http://www.schoolsucks.com provide term papers on many subjects and links to others sites that offer to do research for a fee. Biology papers easily found on “School Sucks” include essays on Marfan’s syndrome, Mitochondria and Chloroplasts, and Eukaryotic Organelles.

Faculty can limit the use of prewritten papers by providing writing assignments that are specific to class discussion topics or specific readings or which ask students to explore a new perspective. The simple assignment to “write about a genetic disease” may be easily fulfilled by papers found on the Internet, while
the assignment, “Write a letter to your grandmother explaining the genetic disease “x” which your cousin was just diagnosed with” is harder to copy directly and probably results in better work as well.

Students may also “borrow” sections of papers from the Internet. While the sources of these are difficult to trace, they are easy to detect because of differences in writing style and use of vocabulary. Students need to learn how to quote and reference Internet sources in order to integrate them into research reports.

B. Enhancement of Class Presentations. Class presentations can be enhanced with video and visuals from the web. Faculty have access to easily projectable images from sites like Cells Alive (http://www.cellsalive.com), the Bock Laboratory of Virology at University of Wisconsin and many more on line collections of images. Cells Alive has video clips of E. coli multiplying, and enhanced micrographs of macrophages engulfing bacteria. The CDC has on line slide sets on epidemiology of Hepatitis, of AIDS, and tuberculosis, among others. The quality of these images enhances classroom presentation, and introduces students to the resources that researchers and professionals use. The use of these pictures and others can model resources on the Internet and can be a starting point for student research and presentation. By using these materials in class, faculty communicate to students that they have accessed sophisticated resources and can use them themselves. In my classroom, I showed one student how to do an Internet presentation, and the other students observed and were able to develop their own presentations.

C. Student Research - Unguided. Faculty can ask students to use the Internet for research, but without guidelines, it is wasted time. Recommendations to use primary sources are forgotten as “great” sites are discovered. Students find authoritative reviews mixed in with lecture notes and warnings of gloom and doom from random authors. Or, alternatively, students do a poorly directed search and end up with non-specific findings. Consequently, the quality of information is varied, and students may waste a lot of time. I find that unguided research on the Internet is only valuable as an example of how not to do things.

D. Student Research - Guided. Faculty can improve the Internet experience for students by advanced planning and guidance. The research experience improves if students develop guidelines to judge quality, if they use the web to contrast varying opinions on topics of interest and if they are introduced to internet sites of links developed for research in the field they are exploring. These introductory exercises help bridge the transition from Internet for shopping and play to Internet for scholarship.  

1. Quality. One approach to introduce students to the variable quality of the web as to provide students with a questionable but respectable looking web page and ask them to evaluate it. One of my favorites was a news release on a research study entitled, “Chocolate doesn’t increase cholesterol levels.” The article appeared credible (sadly it is no longer posted on the Internet) but its address revealed that it had been posted by the Candy Organization of America. A little probing on their web site brought the reader to the visions of sugarplums that highlighted their page. Students here could also critique study design and ask about study sponsorship. Students also note on this page that there are no references. One might also conclude that the research was done at the Pennsylvania State College of Medicine in Hershey, Pa.

Although this page is no longer accessible, others of similar quality and commercial sponsorship exist.

Another way to introduce students to evaluating the quality of Internet resources is with a specific assignment that contrasts different approaches to the same topic. An example of this can be found on http://www.beloit.edu/~biology/evaluate.html. (see Figure 1) This page was prepared for a class on emerging diseases, and it illustrates the problems of reading articles without looking at the sponsors. These articles are quite convincing, but they seem to say different things. Students are challenged to look at who the writers are and what their biases are. They can also be asked to evaluate the scientific credibility of the work they are reviewing. Does it clearly annotate references? Are the references from reputable journals? What are the credentials of the authors or the sponsors?

The activity above can also demonstrate the results of using different search terms in finding scientifically credible resources. This exercise uses articles found by searching for “vaccination” articles. A search on “vaccination” yields substantially different results than one on “immunization”, which is still different from “pediatric immunization.” “Vaccination” finds articles advising parents to avoid immunizations, while “immunization” finds scientifically recommended practices and medical research.

From Microbiology, a topic that raises controversies is the irradiation of food to retard bacterial growth. Students can learn to do a search by typing in “food irradiation”. Articles are posted from university sources, the American Dietetic Association, and several anti-nuclear groups. Students then need to judge not only the content quality of the articles they read, but also the source of the information. This reading can become the basis for a critical thinking activity.
2. Guidance. Guidance in developing a list of acceptable web sites or links to online journals may help students structure their Internet based research through reputable sites. Many professional groups have set up lists of related web sites. The American Society for Microbiology home page has links to a wide range of scientific sources at http://www.asmusa.org/others.htm. The Centers for Disease Control Office of Emerging Infectious Diseases lists resources at http://www.cdc.gov/ncidod/id_links.htm. The reference list prepared by the Partnership for Food Safety Education at http://www.fightbac.org/links/index.html has an excellent set of references on food safety. The pre-research planning by the faculty member, both identifying specific sites and on line bibliographies will increase the profitability of student research and decrease student frustration. It also allows the teacher to outline acceptable and dubious websites and to prepare a format for citation. I find that web research should be cited in standard bibliographic format, with the web address (URL) and date of contact listed at the end. Students may need guidance to learn to identify
the author on many web pages, especially those from professional organizations.

3. Expanding activities Internet research can be constructed to form an open ended textbook for many science classes. Hot links to strong visual representation of micrographs, molecular visualizations, and other biological images and interesting web sites allow students freedom to explore while increasing their understanding of the topics. I have used web sites with photomicrographs and visualizations of virus structure to complement the first session using microscopes in Microbiology (http://www.beloit.edu/~biology/microscope.html). This web search expands the students’ visual understanding of the bacteria and protozoa that were just dots under the microscope. Assignments that provide access to various web sites introduce students to the potential of the Internet for scientific research. In a class on Emerging Diseases, I gave students three references on the Bubonic Plague to review, and then asked them to find and review two additional internet references on their own. This was preparation for further research on diseases of their own choice. (see http://www.beloit.edu/~biology/activities.html for this activity.) Remember, however, that students often don’t have time to explore the best-designed web sites unless they have an assignment that encourages them to be there.

E. Student research with web based scientific tools. The most exciting possibilities for use of the Internet are with professional data sets that are shared. Online Mendelian Inheritance in Man, the Weisman Institute Database http://bioinformatics.weizmann.ac.il/cards/ and other on-line databases that allow students access to scientific data are examples. The Virtual Fly and the Visible Human are further examples of available material which provides data for classroom use. Class projects need to be created to have “real” value, but students can interact with real data rather than simulations.

F. Construction of web pages, based on all of the above. Students can publish class papers and projects on-line, using “What you see is what you get” programs like Pagemill, and with templates for papers. This activity provides an introduction to web credibility and to responsible research and reporting. Faculty needs to be aware of responsibilities to the academic community for accuracy and for protection of copyright as students prepare pages for publication beyond the university to the “universe.” One faculty member was made painfully aware of this when a student completed a paper on a tropical disease and published it on the class web page, linked to the Biology web page and the University web page. Within two weeks the professor was contacted by a researcher from the World Health Organization who objected to his information being used on the web page without appropriate quotes or citation, and who threatened to contact the Trustees of the University.

Students can easily “borrow” text or images from other web sites to enhance their web pages. These certainly increase both the visual appeal and the intellectual challenge of these pages, but images should not be used without explicit permission of the site sponsor. Some of these images are copyrighted, and others are “sold.” Often site sponsors are happy to have their site linked to the student page, but not to have their images used directly. The issues of intellectual property are still in discussion, but it’s important to try to be as legal as possible.

Faculty will find that students readily adopt web-publishing tools, and may enhance their pages in sophisticated ways. A quick introduction to web page construction may be enough for most of the students. Faculty who lack expertise need only to find a helpful student to enhance the learning of the others. See web pages developed by non-majors at Beloit College at http://www.beloit.edu/~biology/healthdis.html.

Students who prepared their own web pages expressed a greater appreciation of the value of Internet communication, and a greater skepticism about the credibility of web resources. They had only to realize the ease with which they became Internet authors to see that everything on the Internet isn’t “the truth.”
Conclusion

The use of email and the Internet provide great opportunities for students to improve communication with faculty, to enhance library research skills and to use real data in generating questions for further study. Although diving into cyberspace may seem daunting to the novice, preparation by faculty can greatly enhance student research experiences. It is our challenge to use the Internet as an infinitely, expanding classroom, rather than a “quick and dirty” substitute for real study.

Sources Cited

Lederberg, J. (1997) "Infectious Disease as an Evolutionary Paradigm" Emerging Infectious Diseases 3(4): 417-423
Fass, Marion. (1997) "Biological Issues: Emerging Diseases." [URL]
Fass, Marion. (1997) "Evaluating Internet Resources". [URL]
Fass, Marion. (1997) "BioIssues: Understanding Health and Disease". [URL]

Genome & Bioinformatics. (1997) "GeneCards: Human Genes, Proteins and Diseases (Weizmann)". [URL]
National Center for Infectious Diseases. (1998) "Emerging Infectious Diseases Resource Links". [URL]
Sullivan, J.A. (1998) "CELLS alive!". [URL]
The Partnership for Food Safety Education. (1998) "Hot Links". [URL]

ACUBE 42nd Annual Meeting

Rockhurst College
Kansas City, Missouri
October 15-17, 1998

Are We Preparing Global Citizens: Aware, Active, and Accountable?