Creating an Ocean Science Education Website: A Very Brief Primer for Scientists

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Science educators frequently discuss the importance of incorporating "real" scientific data into their lessons. Basic science concepts and theories that students see as dull and difficult to grasp become compelling when taught with examples from current research and recent events. By connecting with current scientific research, students understand that science is much more than the factual information in their textbooks. It is an exciting, relevant and ongoing process of exploration and discovery. In the past, educators who wanted to bring current science into their classroom lessons relied on newspaper and magazine articles, educational television, and perhaps a classroom presentation or field trip led by a scientist from a local university, industry, or government agency. However, with internet access, students are able to connect with scientists and their research activities in seconds, any time of day or night. In many instances, the school-scientist connection is two-way, with scientists and learners interacting via email and videoconferencing while the scientists are actively conducting research in the laboratory, aboard ships, and in remote field sites. As film and television made Jacques Cousteau's ocean adventures accessible to earlier generations, the internet is now providing a mechanism to not only inspire and educate, but to include students directly in the excitement of marine research and exploration.

Ocean observing systems (OOS) are adding another dimension to the potential of the internet as a science education tool. Providing a stream of detailed information from thousands of points around the globe, these systems will help scientists build a more complete understanding of the dynamic global ocean environment. In addition to their importance to primary researchers, these data are useful to others, including educators and students. How can we efficiently and effectively share this information with non-researchers? What information, and how much, will various users need and want from the continuous stream of data that the observing systems are capable of delivering? This article will focus on a specific strategy for delivering OOS data to a specific audience: websites for educators.

The best websites for K-12 science education are:

- Focused specifically on the target audience of educators and/or students
- Based on current, accurate scientific information and data
- Correlated with national science education standards
- Enhanced with content-relevant interactive elements, such as animations, quizzes, "ask-a-scientist" e-mail connections, student activities, printable lesson plans, and links to other websites
- Fast loading, without the need for special software or plug-ins
- Visually attractive, with a graphic design that does not detract attention from the purpose of the site, but rather supports and enhances the content

Designing a useful website for science education

When scientists embark on the creation of their first publication targeted toward the K-12 education community, they soon realize that it takes much more time, effort, and skill than they originally anticipated. Developing and packaging effective learning resources in any media, including the internet, is not easy. It is wise to partner with a science educator and a web designer early in the planning stages of the website, preferable during the development of any research proposal that includes an educational component for the public or for K-12 students. Scientists often fail to budget enough time and money in their proposals for education, and

reviewers will look for evidence that this part of the project has been planned with input from professional educators.

Classroom teachers understand the abilities and limitations of students in various age groups, not only in their scientific knowledge but also in their access to and experience with computers. Teachers are also the experts regarding the structure of school science curricula, and can advise scientists on where a particular research topic or science concept will most likely dovetail with specific grade levels and courses. Many schools have restrictions on internet access and limit what type of software may be downloaded. A knowledgeable educator working with a website designer can avoid building a site that may, due to hardware or software restrictions, turn out to be inaccessible to many in the intended audience.

It is not difficult to find web-based science education resources, but the number of sites is so large that reviewing examples can be overwhelming and time-consuming. Using a standard search engine does not guarantee that the resulting sites are scientifically accurate or current. Many educators, with very limited time for web-surfing and a need for assurance that they are using accurate and up-to-date science information, start their search by using a portal science education website such as the Bridge (www.marine-ed.edu/bridge), or NSF's Digital Library of Science Education (www.dlese.org). These sites provide links to hundreds of quality examples of peer-reviewed science education sites, using an organizational scheme tailored for educators (grade level, subject area, etc.). Scientists will also find these portal sites useful in locating examples of web-based science resources that have been judged by educators and scientists as useful, appealing, and accurate. When examining educational websites, you should note not only the information content, but also the variety of graphic designs, the use of interactive features, and the depth and breadth of topic coverage, and the target audience, particularly whether the site is geared toward elementary grade students or an older audience, including the public.

In addition to websites, science textbooks are good resources to illustrate how K-12 science topics are organized and can be particularly useful to locate where specific research topics fit within the general science curriculum. Even though ocean sciences may not be included as a major focus for a particular grade level, there are probably related topics in physical science, chemistry, and geology that could be enhanced by supplementary activities based on ocean research. Textbooks are also useful in illustrating the reading level and the degree of complexity of activities and discussion questions at various grade levels.

National education reform movements have led to the development of science education standards that usually determine what concepts and skills are taught in public schools and at what grade levels they will be addressed. A description of state-level educational standards is usually available on each state's Department of Education website. Most state standards are coordinated with or similar to the National Science Education Standards. The Bridge website has a brief summary of these standards (www.vims.edu/bridge/standards.html), and the National Academy Press website provides an excellent overview (www.nap.edu/readingroom/books/nses/html/overview.html). For a more in-depth look at how science concepts and topics are linked both to each, see the Association of Advancement in Science's Atlas of Science Literacy (www.project2061.org/tools/atlas/default.htm). This is another area where an experienced classroom teacher can be a major asset in developing web-based science activities, by correlating each activity as well as the science content directly with the national science standards, as well as state standards if appropriate.

A good educational website is much more than a collection of text, data charts and graphs, photographs, and links to related websites. While all of these elements can be included, a well designed science education website should tell a coherent and interesting story that helps the user develop a greater knowledge and understanding about the subject. This result comes about primarily from good design, both graphically and conceptually.

Here are some general guidelines to consider when planning the content and appearance of an educational website:

- Communicate immediately the relevance of your research to your readers. The website should engage visitors with the first frame. See for example the introductory page of the American Museum of Natural History's "Black Smokers" website, www.amnh.org/nationalcenter/expeditions/blacksmokers/black_smokers.html.
- Keep language simple and direct. Avoid using a lot of scientific jargon, acronyms, and abbreviations if simpler terms can be substituted. However, include terminology that is used so commonly in your field that it is necessary for a complete understanding of the topic, but define and explain each term when it is used for the first time. A glossary linked from the text pages can be a useful and efficient feature, especially if there is a great deal of technical vocabulary that needs to be defined.
- Construct charts and graphs with care. For elementary or middle school, limit data presented to one independent variable and one dependent variable at a time. Many high school students can work with multiple variables, but avoid trying to compress too much data into a single graph regardless of the level of your audience.
- Lesson plans and student activities should relate directly to the scientific concepts that are the basis of the website. Include step-by-step procedures for teachers and students to follow. See National Geographic's lesson plan on waves for a well-organized example of a lesson plan for upper elementary grades: www.nationalgeographic.com/xpeditions/lessons/07/g35/wavesheights.html. Equipment and materials for laboratory and field exercises should be easily available to teachers, and safe for students to use. Many laboratory chemicals are prohibited for use by younger students, so check OSHA regulations.
- A site does not necessarily have to include animations, audio, streaming video or other enhancements to be useful to educators. However, the best websites offer more than screen after screen of text. Attractive and appropriate graphics and interactive features not only make a site more appealing, they can also greatly enhance the viewer's learning. See the Office of Naval Research's "Science and Technology" website for an effective use of animation to illustrate a rip current: www.onr.navy.mil/focus/ocean/motion/currents2.htm.

  For an example of a creative use of a short, simple video clip to illustrate a concept see the Rutgers C.O.O.L. classroom site: www.coolclassroom.org/cool_projects/lessons/miniunits/lesson1.html.
- The site should be quick-loading. Although high-speed internet connections are becoming more common in schools, modems are still widely in use, and many educators and students use modem connections at home.
- The site should be easy to navigate, with a limited number of levels to click through so that the user doesn't get lost in the website. You should be able to easily find your way back to the home page and the site directory from any page on the site.
- Try to avoid features that require the viewer to download special plug-ins or software, unless these are absolutely necessary to the interpretation of your data. If you include streaming video, audio, and animations, be aware that these enhancements may not be easily accessible to audiences with older computers and slow modem connections.
- Graphic images and text should be large enough to be legible, but compact enough to minimize scrolling. Backgrounds should be plain so that they do not interfere with reading.

- There are specific guidelines for making websites accessible to users with disabilities. See the Web Accessibility Initiative website for background, tips and guidelines (www.w3.org/WAI/about.html). Federal websites are required to meet accessibility standards.

Selected examples of ocean education websites

NOTE: Due to space limitations only a very small number of examples are included here. These websites were selected by the authors to illustrate specific approaches related to target audience, graphic design, and differences in depth and breadth of topic coverage. Many more examples of excellent ocean education sites exist; see Bridge (www.marine-ed.edu/bridge), or NSF's Digital Library of Earth Systems Education (www.dlese.org) for links.

American Museum of Natural History Expedition: Black Smoker (www.amnh.org/nationalcenter/expeditions/blacksmokers/)

This site for teachers and students describes research expeditions sponsored by AMNH, University of Washington, and NASA to recover black smokers. Through the *Expedition* section readers can find scientific background information, read the expedition plans and journals, and correspond with scientists. The *Engineering* section presents the physics involved in the recovery mission, challenges students to design their own recovery plan, and links to several students' designs.

The C.O.O.L Classroom (http://www.coolclassroom.org/home.html)
This site from Rutgers Marine and Coastal Sciences (in partnership with the Jacques Cousteau Estuarine Research Reserve) combines clean, attractive graphics, easy navigation, and a myriad of interactive instructional strategies to engage middle and high school students in the Coastal Ocean Observatory Laboratory's studies of the ocean waters off the coast of New Jersey. See the C.O.O.L. Room's main website http://www.thecoolroom.org/ , which very effectively provides useful and user-friendly data for a broader audience, including surfers and anglers.

Water Science for Schools (http://wwwga.usgs.gov/edu/)

This site from the United States Geological Survey is a comprehensive resource about water especially for K-12 teachers and students. It presents information on basic water properties, the water cycle, and water quality and use issues. It features an activity center with questions and surveys, a question & answer section, pictures, data, and even a certificate of completion for the website.

Ocean World (http://oceanworld.tamu.edu/)

This comprehensive site developed by the Jason Education Project at Texas A&M University has a variety of resources for audiences from upper elementary to college faculty and the general public. Content information is linked to real-time data sets, downloadable college oceanography course, online college courses, and lesson plans for teachers of grades 3-12.

USGS Water Quality of San Francisco Bay (http://sfbay.wr.usgs.gov/access/wqdata/)
This is a good example of an effective educational site that interprets project data for a broad general audience (useful for but not specifically designed only for K-12 educators). It provides data from recent hydrographic cruises with detailed explanations of how to read and use the information. Special features of this site include a website navigation guide, descriptions of the parameters measured, and helpful hints on interpreting images and graphs.