SPACE SCIENCE EDUCATION USING THE WORLD WIDE WEB. P. J. Mouginis-Mark, Hawaii Space Grant College, HIGP/SOEST, Univ. Hawaii, Honolulu, Hawaii, 96822.

Introduction:

Recent developments in the speed, diversity and level of interaction provided by material being offered over the World Wide Web (WWW) enables new approaches in space science education to be developed. No longer is it necessary for a teacher or college professor to prepare slide sets or video tapes for widespread distribution; instead much of the work can be focused on developing a comprehensive data base on a single server and in educating students to access the Web. For planetary sciences, a fine example of the breadth of space science information is provided by the Lunar & Planetary Lab at the University of Arizona (1). This form of presentation of selected images of the Solar System has numerous advantages, including the timely presentation of new results, and the iterative development of ideas and data bases compared to the longer term task of rewriting a text book or a new CD-ROM.

Educating high school teachers, undergraduate students, and our professional colleagues via the WWW is being undertaken through several different projects in Hawaii. Although there is still a reluctance (frequently caused by hardware limitations or connect charges) for the target groups to utilize the full range of resources available on the Internet, appreciable progress seems to take place almost every month. To help promote this growing trend, some of our on-going educational projects are now described.

A Virtual Field Trip of Hawaii:

The WWW will be used extensively for two different projects related to the presentation of volcanological information to the general public and researchers. Through our work on terrestrial volcanoes, we have developed many collections of slides of volcanoes (2) and volcanic processes (3). As part of a NASA Cooperative Agreement Notice (C.A.N.) project to place science data on the Internet, we are constructing field guides for the lay-visitor to Kilauea volcano and the post-erosional volcanics on Oahu. Through a combination of satellite images (Landsat, SPOT, SIR-C/X-SAR), aircraft data (AIRSAR, TIMS and TMS), and ground photographs, we are building a data base that both shows the volcanic landscapes and provides an interpretation of the scenes (4). This activity can also be taken a step further in the case of educating graduate students who are interested in planetary volcanology. In conjunction with a field workshop that we will be running on Kilauea in August 1995, a page on the Hawaii Space Grant Consortium's Home Page (5) will be developed that we hope will challenge the participants to conduct field work in a manner that is comparable to planning a lunar EVA. This will be accomplished by having the user select a few pages from the total available. They then fill in a multiple choice questionnaire after seeing a limited number of the scenes that are available. This questionnaire is then automatically graded and returned to the user with suggestions on which parts of the "field work" need to be better planned or understood.

Space Grant Undergraduate Fellowships Projects:

In Hawaii, our Space Grant Consortium supports ~20 undergraduate students each semester with $1,000 stipends and tuition waivers in order that they can gain experience in conducting their own space-related research (6). Many different types of projects are supported, including planetary geology, Earth remote sensing, space engineering, and astronomy. In many instances, one of the major hurdles that a student faces before he or she has an approved project is the identification of a data set to work on. A common problem is that the students have heard about a data set such as the Clementine images of the Moon (7), or are interested in the planning for Mars Global Surveyor (8) and Mars Pathfinder (9), but only a few faculty members have these data and these faculty are not always able to mentor a student. Now that many of the images and background information are on the Web, conducting planetary projects have become much easier while at the same time not placing any additional burden on on-going research projects.

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A more difficult issue exists with undergraduate Earth observation projects that involve remote sensing data such as Landsat, ERS-1, JERS-1 or SPOT. There is no server that provides these images because the data are sold commercially, although through our work on the Earth Observing System's Volcanology Team we have developed a compendium of links to the available satellite data sets (10, 11). We have found that the most effective approach in this instance is to limit the student to a project that uses data already on the Web, rather than deal with copyright issues for data access. Thus some of our student projects substitute aircraft data or digitized Shuttle photographs (12) for satellite multispectral images, while others change their study area to a part of the world where data are available.

Future Plans:

One of the key limitations of most Home Pages on the Web is the passive way in which information and data are presented to the user. If this medium is to be used effectively as an educational tool in the school and college environment, a way has to be developed for the user to interact with the information so that their comprehension can be evaluated. In the case of our Virtual Field Trip of Kilauea (4, 5), this evaluation will focus on how well the user can answer a set of questions as well as keeping a record of what pages they study to answer a question so that we can see if they really understand the topic.

Another approach is the one taken by the Lawrence Berkeley Laboratory (13), which attempts to introduce to the user the concept of 3D visualization through the use of high resolution MRI imaging and mechanical sectioning of a frog! This Home Page allows the user to explore (in 3-D) the physiography of the frog, describes its different organs, and shows how the image reconstructions were made. A second approach is one taken by the University of Southern California with the Mercury Project (14), which allows users to tele-operate a real robot arm moving over a terrain in southwest Nevada. Users are able to direct where the arm moves over the physical environment, and there is a comments page where people discuss the interpretation of the images that are obtained. In the case of planetary exploration, one could envisage small rovers being operated in this manner, provided that necessary spacecraft safety issues were taken care of and were out of the control of remote Web users!

Conclusions:

Use of the World Wide Web for formal education in space sciences is rapidly approaching. Current hardware problems such as the limited capabilities of typical machines that students have access to, the lack of connectivity to the network in the school system, and the slow access speeds over a modem, are all improving. Data bases are also rapidly expanding not only in the number of images and amount of text provided, but also in the creative manner that the user is challenged to interact with the information. It promises to be a fun future!

References: The following are the URL addresses for Home Pages cited above:

1) http://seds.lpl.arizona.edu/other.html
2) http://www.geo.mtu.edu/eos/volcanolist.html
3) http://www.geo.mtu.edu/eos/education/
4) http://camille.gsfc.nasa.gov:80/rsd/awards/Hawaii.html
5) http://satftp.soest.hawaii.edu/space/spacegrant/
6) http://satftp.soest.hawaii.edu/space/spacegrant/fellowship.hsgc.html
7) http://clementine.s1.gov/images/images.html
8) http://mgs-www.jpl.nasa.gov/
9) http://mpfwww.jpl.nasa.gov/
10) http://www.geo.mtu.edu/eos/otherlinks.html
11) http://www.geo.mtu.edu/eos/satlinks.html
12) http://images.jsc.nasa.gov/html/home.htm
13) http://george.lbl.gov/ITG.hm.pg.docs/Whole.Frog/Whole.Frog.html
14) http://cwis.usc.edu/dept/raiders/

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