This paper focuses on experiences gained through projects oriented at the enrichment of biological and physical science curriculum through the incorporation of earth observing satellite data. The basic premise is that earth observing satellite images or information and/or measurements derived from images can provide unique insight into science topics and/or can provide another perspective about the topic. It is also thought that remote sensing from space catches the students' attention and sparks their interest in the topic being addressed.

One project on which this paper is based was oriented at the high school level and another project was oriented at community college academic programs. Both of the projects followed the same general approach which involved the selection of a science topic, statement of the fundamental concepts related to the topic, introduction to earth observation technology related to the topic, and the illustration of the results of earth observation that provides information about the topic. These projects involved the use of multimedia software to assemble and present the material in the form of text, hypertext, video clips, animation, graphs, and images.

These projects involved the development of the material in conjunction with instructors actively teaching the courses to which the science topics pertained. Products were in the form of computer-implemented learning exercises. Once preliminary products were developed, they were distributed to a wide range of instructors of biological and physical science courses for evaluation and feedback before being put into final form. This product will be distributed in the form of a CD and posted on an Internet web site. However, it is thought that the faculty enhancement provided during the course of these projects and the lessons learned during project activities were also valuable products.

The object of this paper is to discuss the lessons learned in the process of developing the products in the manner described above and to suggest solutions to some of the problems encountered.

LESSONS LEARNED

1. It is necessary to provide training to instructors/teachers who are not familiar with remote sensing technology used in earth observation by satellite and aircraft. Most teachers/instructors who were not familiar with remote sensing technology were reluctant to incorporate such earth observation material into their courses without some training. In the case of the community college project, the first step was to provide an introductory session of four hours duration through an interactive, distance-learning delivery. This was scheduled through two two-hour sessions separated by one week and offered between 3:00 p.m. and 5:00 p.m. The strategy was to pick a time that was most convenient to the instructors, and to keep this training at a level and duration that would allow them to determine whether or not they were interested in receiving more training. For those who were interested, an option for another two-day session or a five-day session was provided. The two-day session was intended for instructors who wished to use earth observation images/measurement in the courses, but did not want to be involved in creating new curriculum support material that involved manipulating or analyzing the digital images. The two-day course included an introduction to basic principles of remote sensing, a description of the mechanics and design of sensors, illustrations of information content of images with respect to science topics, and an explanation of how data was transmitted to earth and processed for the user. The five-day course was intended for instructors who wished to be involved in using earth observation data to develop their own learning exercises and material for classroom use. It encompassed the material taught in the two-day course plus the use of image analysis software with hands-on instruction using MULTISPEC[1], freeware software developed at Purdue University for NASA, and demonstrations of several commercial image analysis and GIS software packages. Such training for the community...
college project was provided through the facilities of a local university as "non-credit" courses. Although time constraints in this project did not permit the arrangements necessary for offering college credit for these courses, it is recommended that such arrangements should be made for this training. It was thought that the five-day course was the equivalent of a three credit-hour course during a semester.

(2) It was also necessary to provide training in the use of multi-media software and for certain aspects of finding and downloading images available from sources through the Internet to some of the faculty who wished to develop their own curricula support products.

(3) Many schools, both high schools and community colleges, did not have computer/projector systems for effective use of digital data in the context of a classroom lecture. Therefore, the curriculum support material was provided to the students as a laboratory exercise, and material made available through a library-based computer system as self-learning, reference, or individual student projects. However, the latter uses were the most common because the laboratory computers usually did not have audio capability.

(4) The original strategy in conducting these projects was to keep the technology compatible with the equipment that existed in the schools. When these projects began, surveys of the Mississippi schools indicated that most computer equipment did not have sound cards and speakers, presumably because audio can be disruptive in a laboratory or library setting. Therefore, many of the learning exercises were prepared without reliance on an audio component. However, because video clips combining audio and visual material was very effective for illustrating and teaching certain aspects of science topics, it was decided that a limited amount of audio should be included. The feeling was that if audio component was not relied on too much or to make a central point crucial to the content, then those students using equipment without audio could simply by-pass buttons for video clips or audio information.

(5) The preliminary survey of equipment in the schools indicated that most computer systems available to the students in a science laboratory setting did not have CD drives or had drives that were very slow (2-speed). Furthermore, other than computers associated with the libraries, there were very few computers connected to the Internet. Therefore, it was decided to make computer-implemented curriculum support products available on 3 ½" floppy in compressed form. However, within one year when the first products were ready for evaluation, and especially within two years, many schools had upgraded their equipment to include Pentium computers with 8-speed CD drives, and some, especially the community college's, had taken steps for campus-wide Internet connections. Subsequently, a decision was made to place the material on a CD for distribution. It is now our opinion that, when planning a future product, one must take account of the existing equipment but should consult with the school's administrative officials relative to budget planning for future upgrades, and scope projects to technological levels assumed in their plans.

(6) The time available to high school teachers and community college instructors to attend meetings or workshops to learn about new educational technology or to use that technology in the preparation of classroom lectures, lab exercises, etc. is very limited and is a factor that must be considered in planning projects involving curriculum development and support. We found the "distance learning" sessions are a partial solution. However, scheduling of meetings and workshops immediately before or after the academic school year or during breaks is also necessary. In the case of a few schools where faculty meetings were regularly scheduled (usually one hour every Friday), communications relative to these projects were greatly facilitated.

EVALUATIONS

At the time the paper was submitted, only the evaluations of the CD product developed for the high school level have been completed. The CD was sent to about 300 high school science teachers who participate in the GLOBE[2] program, and had received training in remote sensing technology through that program. Although the responses were mainly oriented to the specifics of the CD, some general conclusions were derived from the responses as follows:

(1) About 6% of the teachers did not have computers equipped with CD drives and could not run the CD.

(2) Another 6% had difficulty running the CD because of slow machines, slow CD drives, or no audio capability.

(3) Instructions provided with the CD indicated that a display setting of 800x600 was necessary. Some teachers did not know how to change display settings on their computers or
were not allowed to do so without consulting the computer technician for their school.

CONCERNS FOR THE FUTURE

These experiences with the development of science curriculum support with earth observation images has also given rise to some concerns for the future of such endeavors as follows:

(1) Satellite-acquired earth observation data or products derived from these data must be provided to the schools free-of-charge or at a very low cost or their budgets will not allow the use of this source of information.

(2) There is wide variation in the availability and technological level of electronic equipment within the school systems in the U.S. Until, the “have not” schools are equipped to take advantage of digital data products for curriculum enhancement, it will be difficult for them to use earth observation data most effectively.

(3) Although significant progress has been made towards Internet connections in high schools, there are still many schools that do not have such connections. Although the distribution of curriculum support material can be done most effectively through electronic transmission, reliance on this method of distribution is not possible until a majority of the schools are Internet-connected.

REFERENCES
