Technology and Astronomy Education

Chair: Laurence A. Marschall  
Department of Physics  
Gettysburg College  
Gettysburg, PA  
USA 17325  
Fax: (717) 337-6666, Internet: marschal@gettysburg.edu  
Recorder: John Safko

Introduction: Identifying Useful Technology

Technological advances in the last decade, without a doubt, have made many new modes of teaching and learning possible in astronomy. At the session on Technology and Astronomy Education we began by identifying those aspects of recent technology which were applicable to astronomy education.

Among the technological advances the members of the group were aware of were:

- Computers: which are used to run telescopes, process digital data, run simulations, and provide demonstrations for lectures and labs.
- Software: including programs for data analysis and simulations. Images can now be stored and manipulated digitally. Planetarium programs like *The Sky*, *Dance of the Planets*, and *Voyager* have become popular in introductory astronomy labs, and simulation programs like those of Project CLEA are making advanced techniques available for hands-on exercises.
- CCD Cameras: make it possible for students to make their own images of deep-sky objects much more easily than they could using photographic techniques.
- Automatic Photometric Telescopes and other robotic and/or remote-controlled telescopes: Provide data for instructional purposes with a relatively low amount of student labor.
- Videotape: There is a growing library of films and supercomputer simulations available for lectures.
- Videodisk: Provides a wealth of still image and motion picture data for use in the classroom and the lab.
- The World-Wide-Web: Makes a wide variety of data, animations, software, etc. available to students and teachers at the click of a mouse. Facilitates communication between people of shared interests. Provides a medium (html documents) for generating hypertext documents that can be used in classes.

Problems Raised by Technology in Astronomy Education:

Participants were in general agreement that there were great opportunities for increasing the effect of astronomy education through the new technologies. But they voiced a number of concerns:

One needs to know what materials are available, what they do, and how to get
them: the proliferation of technologies, especially software and web sites, is occurring so rapidly that it is an effort to keep up. Teachers and students need an efficient way of matching their needs and interests to the technology.

It takes time and effort to learn to use the new technology in old courses. Change in classrooms takes place much more slowly than change in technology, especially when a new technology opens up a whole new mode of teaching. Video, for instance, can easily be incorporated into existing lecture courses. Using hypertext on the web, however, implies an entirely new structure to the course, perhaps including a strong self-paced element. Both high school and college teachers indicated that they needed free blocks of time and outside instruction to learn particular new techniques.

Students need to be computer-literate to learn the new technology. Participants seemed to feel that this was less of a problem than in the past. Depending on their earlier educational background, of course, students in the last few years seem to take computers for granted. They are less intimidated by them than they used to be, and they are familiar with the fundamental grammar of the most popular operating systems.

Technology should not be used just because it is new. It should be used with an eye to:

- **Balance:** Technology cannot solve all the problems of astronomy teaching.
- **Appropriateness:** Technology need not, and probably should not, be used if a more direct and simpler method with do. For instance, it is better to learn the constellations outdoors, if possible, than to memorize their appearance on the screen of a computer monitor.
- **Applicability:** Software that runs on a workstation is hardly applicable for use in 5th grade classes. Nor do we want to teach spectral synthesis to students just because the software is available. Teachers should be cognizant of learning objectives in applying technology. Substance should take precedence over glitter.
- **Effectiveness:** Does the technology work in meeting learning objectives? There is very little systematic evidence one way or the other

**Technology costs money.**

- Is it worth it? Equipping a classroom or a lab with telescopes, CCD’s, or computers and network connections costs much less than it used to, but it is still more expensive than using printed photographs and naked eye observations. What is a reasonable cost for a particular situation?
- Who will pay the long term costs? Some of the costs of technology, such as the long-term maintenance and replacement of computers, or the cost of network connections, are not evident in the beginning. It is possible to become dependent on a technology that becomes overly expensive in the future.
- How will we deal with equity between the haves and the have-nots? Some schools have large numbers of computers and Internet connections, others have none. It is possible that we may be creating two classes of students (in the nation and internationally) learning astronomy in quite disparate ways.
The effectiveness of specific technologies in teaching and learning needs to be evaluated systematically. Much of the technology is so new that it is difficult to make informed choices about its wise and economic use.

It is difficult to know what lies ahead. Technology is changing so rapidly, and in so many unforeseen ways, that one is either (1) far behind and perhaps not doing things as well as one could, or (2) riding blindly on the crest of the wave, unsure of whether one is being truly innovative or just trendy.

**Suggested Solutions**

The following suggestions were put forward, not as all-purpose solutions, but as measures which might prove useful in aiding teachers and fostering wise use of the new technology. Existing institutions and publications may be able to provide the means for meeting some of the challenges we have noted.

We should encourage the creation and maintenance of online resource listings for astronomy education, such as that proposed by the AAS Education Committee.

Popular journals, such as *Mercury*, *Sky and Telescope*, *CCD Astronomy*, and *Astronomy* are appropriate places for news and information on educational resources.

There may be call for the creation of an online journal of astronomy education, and/or the creation of astronomy education news groups or mailing lists.

High school teachers and college teachers do not read the same journals. News of astronomy technology useful to specific audiences should be made available through journals read by those audiences. For instance *The Science Teacher* and other publications of the National Science Teachers' Association are the appropriate media for reaching teachers of K-12 students, while the *American Journal of Physics* is best for college physics teachers.

Professional organizations (through their small grants programs) and governmental agencies should support grants for research into the effectiveness of technology in astronomy education. Innovators in the use of technology should be encouraged to carry out such studies.

Professional organizations, at national meetings perhaps, should support training sessions and workshops on the use of technology for teachers. The American Association of Physics Teachers, for instance, organizes several days of training workshops at each of its semiannual meetings.

Astronomers at "well connected" institutions should encourage their schools to foster Internet access at all high schools and colleges. Colleges should, at minimal cost, offer Internet access to local K-12 teachers and students if they do not already have it. Users of technological innovations should mentor local teachers in useful items and techniques.

A national meeting such as this, on astronomy education, should be held every few years.

**Summary**

The above suggestions seem to point to a need for better communication between users and potential users of the new technologies, for active outreach to train potential users, and for the fostering of evaluation projects to help teachers
decide the most fruitful way to use the new resources. Professional societies and governmental funding agencies can play a role in outreach, training, and evaluation. Professional societies can also play an important role in maintaining central web-sites where resources can be listed along with evaluative information. Technological resources for astronomy will continue to grow in an anarchic, organic fashion, but organizations can do more to foster effective application of the latest technology.

Discussion

Garrett.

What is involved in setting up a mailing list (electronic)? Could anyone here volunteer to do it?

Marschall.

It is easy to do but can turn into a time-consuming ("full-time") job.
**Dukes.**

We need to remember that astronomy is basically an observational and not an experimental science. Much astronomy in this country is taught in physics departments by physicists. Physicists are trained as experimental scientists and are not used to dealing with an observational science. As such they are not aware of the problems with dealing with a body of data on individual objects. One thing which could be done would be to devise ways to make physicists aware of this problem. A suggestion is to attempt to involve physicists in observational astronomy research. A related problem occurs when dealing with the K-12 community. Teachers are trained by science educators in the scientific method. This involves certain things that are difficult, if not impossible to accomplish in astronomical research. An example is the control of variables. Astronomers usually cannot do this. We should make teachers and science educators aware of this problem.

**Reynolds.**

Astronomers (scientists) need to learn something to be educators and teachers need to be enlightened about observational methods to expand their narrow view of scientific research methods ("scientific method") where in physics ("not thinking about individual data") or astronomy ("you can't control the variables") things may be really different.

**French.**

As the DPS (Division of Planetary Sciences, AAS) Education Officer, I will be organizing a workshop for DPS members after our fall meeting in Kona, Hawaii. Please contact me for more information.

**Fraknoi.**

I would very much like to see an ongoing organization and newsletter, jointly sponsored by the AAS and ASP, for astronomy educators at all levels. It would be very nice if it could have a low membership fee. It could be a joint division of the AAS and ASP, and could subsume the small and often struggling Association of Astronomy Educators.

**Hill.**

Until the reward structure for professional astronomers (in terms of prestige and salary) rewards teaching as much as research, it will be difficult for us to expect that most professional astronomers will be committed to genuine educational reform in education.

**Hoff.**

Let's not wait 23 years until the next ast-ed symposium, and even if we can't reach agreement on many issues of astronomy education, the "journey may be more important than the destination."

**Hollow.**

Graduate students at University of Western Sydney (Australia) have to take part in outreach programs such as primary school groups/public viewing evenings at our Astronomy Center. Some hesitation but students acknowledge the value of them.
Manning.
Many good ideas have been expressed here, but follow-up will be important. Might it be useful to establish a committee to coordinate, monitor, or encourage the sorts of calls to action expressed here? Perhaps it would be good to have a representative from each of the sponsoring organizations, to maintain communication and interchange.

Pasachoff.
To pick up on Dennis Schatz's earlier statement, let us make a concrete way for graduate students to participate in meetings like this. I propose that for the next ASP meeting on education we invite universities to nominate one graduate student each to have a Fellowship to attend, and to provide that person with free registration and lunch.

Are there any graduate students here? [One hand is raised.]
Alison Procter: I am.
JMP: I am very glad to have you here. In some sense, this meeting is for you. I hope you come to many more.

To make my valedictory statement for this meeting let me associate myself with Darrel Hoff's statement by quoting Robert Louis Stevenson, who said - using the word "hopefully" correctly - "to travel hopefully is better than to arrive."

Richter.
Two general comments:
1) In terms of K-12 education and where astronomy fits in the curriculum: the strength of astronomy is its interdisciplinary nature and integration of science themes, big ideas, and concepts we want kids to learn. Rather than focusing on astronomy as a separate subject or lack of mention in curriculum standards, use the standards to make an argument for teaching astronomy (as integrating subject).
2) Astronomers need to link and learn with and from other sciences active in education - chemists, physicists, biologists, doctors.

Roettger.
There already exists a group whose mission is enabling scientists to become involved in education, do workshops at professional society meetings, collect and disseminate the needed information, etc. In 1994, the National Research Council (NRC) established Regional Initiatives in Science Education (Project RISE) to develop a national cadre of scientists and engineers equipped to participate effectively in K-12 science education reform. (from The Catalyst, 1:1, Jan 1995, Ed. Karen Goldberg)

They advertise "Hold a Project RISE workshop at the next annual meeting of your scientific society" to get information on national, regional, and local initiatives, experience activities, learn how to develop partnerships, etc.

Contact information: Tel.: (202) 334-2110
Project RISE FAX: (202) 334-3159
National Research Council E-mail: RISE@NAS.edu
2101 Constitution Avenue NW
Room HA 486
Washington DC
USA 20418
Karen Goldberg, Editor
Jan Tuomi, Director
Rosendhal.
The general issue of training is going to be critical. If a group of astronomers said they wanted to go into brain surgery, the prospective recipients would certainly ask valid questions about credentials. Other professions regard formal training and professional development as a normal part of career progression and that there is a routine need for the development of new skills. Since what we are doing is at least as important as brain surgery, we are going to have to address the issue of training. The astronomical community needs to become more aware of the current trends in education, become aware of what is and isn't effective etc. We must find out how to arrange this if we, as a community, are going to be effective in education and public outreach.

Hemenway.
[response to Jeff Rosendhal] AAS sponsored a one-day workshop at Lawrence Hall of Science following the AAS Berkeley meeting for 40 astronomers. The LHS staff and ASP staff co-presented. Other professional societies offer 1-day short courses connected with meetings to offer training on various aspects; perhaps AAS and/or ASP should consider something similar to educate astronomers about educational techniques.

Mattei.
I participated in the workshop for astronomers at Berkeley that Mary Kay Hemenway mentioned and found it extremely helpful in learning about hands-on-activities, the kinds of things to consider in giving educational workshops and in being informed about resource materials.

Schatz.
Now is the time, with the new AAS Education Coordinator being hired, to write an NSF proposal to the Astronomy Division to develop a staff development workshop for professors and graduate students – possibly focused on TA and professor instructor teams – that occurs in regional sites, where staff from surrounding institutions come to a common site. It would have to be more than one day – three would be nice.

Shawl.
A followup to both Jeff and Mary Kay ... I've been impressed with the number of people who have overcome administrative roadblocks and accomplished great things. Some professional development to teach us how to be more effective would be extremely helpful.
SECTION III. POSTER PAPERS

Participants were encouraged to contribute poster papers, and many did so. Summaries of most of them are included in the following section. (The non-alphabetical position of the papers by Hennig and Hoff is due to an oversight on the part of the editor.) They include many of the most interesting and important astronomy education programs and projects in North America. A more complete list is included in the appendix. The following posters were presented, but not summarized here.

Chaisson, Eric: Programs and Activities at the Wright Center for Innovative Science Education
DeVore, Edna and Stoneburner, C.: SETI Institute Educational Projects
Heinzman, Tony: Remote Access to Astronomical Images
Mechler, Gary: You Teach Astronomy, but Do You Teach Science?
Sadler, Philip et al.: The Micro Observatory Net, and Project STAR: A New Approach to Teaching Astronomy

Because of the time constraints in the symposium, only limited time was available for poster viewing. In future symposia, more time should be allocated for poster viewing, and the posters should be situated in a single, large, comfortable area.