STEPS AND MISSTEPS TOWARD AN EMERGING PROFESSION

As much a need for the science community as for the nation,
the astronomy education and public outreach profession is [finally] coming into existence.

by Andrew Fraknoi

Every few years, the National Science Board issues a snapshot of the state of science in the U. S. called Science and Engineering Indicators. The most recent (2004) volume makes for fascinating reading for those who enjoy

Project ASTRO teachers build their own model comets with the help of astronomer and noted planet-hunter Debra Fischer (upper right). Photo courtesy of the ASP and Project ASTRO.

nationwide statistics; it is available free on the Web at *www.nsf.gov/sbe/srs/seind04.*

The good news is that the public is overwhelmingly positive about science:

> 85% say science and technology will make our lives better and our work more interesting;
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> 72% say the benefits of research outweigh any harmful results; and
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> 36% say the government is not spending enough money on science research (while only 14% say it is spending too much).

The bad news is that the public's understanding of science in our country is disturbingly low. The report concludes that less than 1/5 of adult Americans can be considered minimally science literate in the sense required for participation in civic society. Think about that—80% of our fellow citizens are not really familiar with the basic concepts of science needed to vote intelligently on ballot measures. Only 22% of adults can correctly explain what a molecule is, for example. And two thirds of adult Americans cannot correctly explain the scientific method to an interviewer.

Teachers also have problems with science ideas. In a recent survey of Wisconsin school teachers who had signed up for a space-science enrichment program, fewer than 20% of the elementary teachers and fewer than 25% of the middle school science teachers knew, for example, that radio waves travel at the same speed as light.

The Curse of Pseudo-science

And it isn't just that the public is poorly informed about science. At the same time, survey after survey has documented the rampant and unchecked spread of pseudoscience (or, as some call it, fiction science or anti-science)—ideas based on outdated beliefs, miracle cures, superstition, and pure misinformation. The popularity of these ideas has received a tremendous boost in recent years by the increase in tabloid journalism on television and the Web. For example, far more people will watch one pseudoscience-filled episode of "Unsolved Mysteries" on television than will be taught an astronomy course by all the members of the Astronomical Society of the Pacific in an entire year.

The National Science Board's full report, *Science and Engineering Indicators 2004*, is available on the web at *www.nsf.gov/sbe/srs/seind04/*.

Apollo 11 astronauts Neil A. Armstrong (left) and Edwin E. Aldrin, Jr., deploy the United States flag on the Moon. Motion of the flag during its deployment has been used as evidence that the U. S. faked the Apollo landings on the Moon. This and other "evidence" of a conspiracy was included in the February 2001 broadcast (and subsequent re-broadcasts) of the Fox television network's program "Conspiracy Theory: Did We Land on the Moon?" Photo courtesy of NASA.

Shows touting UFO landings and abductions continue to be especially popular, as do ghosts and spirits, mythical faces and strange structures on the planets, and, perhaps worst of all, the notion that NASA never landed on the Moon—that the Apollo program was a vast hoax perpetrated on an unwitting public.

A 2001 Gallup poll showed that 33% of Americans believe extraterrestrial beings have visited the Earth, and 42% believe that people are sometimes possessed by the Devil. A 2003 Harris Poll revealed that 51% of American believe in ghosts, 31% take astrology seriously, and 27% believe in reincarnation.

It seems that those of us who are interested in the public understanding of astronomy have got our work cut out for us. And the few thousand professional astronomers in the U. S. cannot do this work alone. We very much need the help of astronomy information intermediaries—planetarium and museum educators, amateur astronomers, writers, media producers, web masters, and teachers. And if we want these intermediaries to do a good job, we need to give them the tools and training they need to address the public at the right level.

A Brief History of Astronomy Information Intermediaries

Readers of *Mercury* are the last people in the world who need to be told about the public appeal of astronomy. Children from 5 to 95 enjoy having their pulses race just a little quicker when reading about such remarkable projects as the Deep Impact mission's collision with a comet and such fascinating discoveries as the acceleration of the expanding Universe. From Galileo's telescopic achievements onward, we know that the public has had a great appetite for news about astronomical discoveries and ideas—the more mind-boggling, the better.

The interpretation of astronomical ideas for the public at large did not long remain the province of scientists alone. From 17th-century poets celebrating the Newtonian world view to 21st-century documentary film makers on the Discovery Channel, we have had a wide range of skilled people whose interest is in making new discoveries intelligible to non-scientists. Often, these interpreters are not devoted to astronomy and physics full time, but also deal with many other subjects in their interpretative work.

But now, primarily as a result of investments by the agency formerly known as

NASA missions have increasingly promoted their science and how that science can be used to improve our understanding of the Universe. As example, consider the Hubble Heritage Project (*heritage.stsci.edu*) and the other activities by the Space Telescope Science Institute's Office of Public Outreach.

NASA's Office of Space Science (as well as by the National Science Foundation, the country's national observatories, and organizations such as the Astronomical Society of the Pacific), a new profession is slowly emerging in our community—that of full-time astronomy and space-science education and public-outreach provider. How is that for a mouthful? Let's just call it EPO provider or astronomy interpreter.

Is It Really a New Profession?

Now, you might argue that planetarium educators have been in the astronomy-interpreter profession for decades, and so have the staff at such magazines as *Sky & Telescope*, *Astronomy*, and, of course, *Mercury*. But these were specialists, working in a sky theater or as magazine journalists, and often doing their job in locations quite separate from the world of astronomical research.

What is different today is that the recently minted astronomy interpreters are often embedded in astronomy and space-science research projects and institutions. And their work frequently covers more than one arena of education and outreach. That is to say, they are often working simultaneously with teachers, with the media, with book authors, with webmasters, with documentary video makers, and with the public.

The reason for the growth in the number of EPO providers can be traced to a number of converging trends in the 1980s and 1990s. Congress began to put pressure on science funding agencies to justify the funding of pure research by highlighting the contributions science can make to the betterment of society. For astronomy, a large part of the benefits to the nation lie in public education, and so both NASA and NSF began to encourage its projects to do more outreach. (This trend was reflected in the "Decadal Surveys" that the astronomy community does every ten years to set priorities for the future. The last two decadal surveys have had much longer sections on "benefits to the nation" and education and outreach than the previous ones.)

The decline in the U. S. educational system continued in these same decades, leading universities and scientific organizations to worry about the continuing supply of future scientists and engineers. Simultaneously, the decline in public scientific literacy led scientists to be concerned about future support of science and technology among voters and their representatives. Thus, many colleges and universities, observatories and research labs, and other science groups encouraged their employees to undertake more education and outreach and even began (in small ways at first) to consider such work in the evaluation of their staff for promotion and tenure.

At the same time, the growth of new technologies, particularly the Internet, allowed public outreach efforts in astronomy to become faster and cheaper (if not always better.) Images from planetary probes or large telescopes could be made instantly available on the Web, fueling further public interest in the discoveries of astronomical research. And, once again, various astronomical institutions saw the advantage of appealing to public support directly by using these technologies. Huge numbers of people have been following missions to Mars and to comets on the Web in recent years.

With all these trends coming together, young people with degrees in astronomy and related sciences began to see some job opportunities in and peer approval for becoming EPO providers. And when NASA in the mid to late 1990s began to require all its new missions and projects to include an educational component, the EPO provider profession really took off.

The NASA Effect

Perhaps the greatest single contributor to the growth of the EPO profession was a change at NASA's Office of Space Science. It began with the appointment of a visiting scientist at NASA Headquarters whose job was going to be to brainstorm how space scientists and space-science missions can do more in education. The second person to hold the position, Cheri Morrow, began to organize more systematic efforts and to envision some standards for being an effective EPO provider. (She has remained an active part of the system she began to envision ever since.)

But the real spark for the establishment of a system for change came from an old Wash-

Based on Brian Greene's book, *The Elegant Universe*, the three-part NOVA television miniseries of the same name—along with books like Dava Sobel's popular *Galileo's Daughter* and Bill Bryson's *A Short History of Nearly Everything*—attempts to deliver to the public science and humans' ways of fathoming nature.

Suzanne Chippindale, ASP Education Manager, and her daughter Kjersti test a new activity for the new Family ASTRO program. Photo courtesy of Project ASTRO.

Maria Acuña helps Spanish-speaking families with Family ASTRO's Viendo en la Oscuridad ("Seeing in the Dark"). Photo by D. Zevin.

A San Francisco Bay Area student models a spacesuit for her fellow Project ASTRO classmates. Photo by M. Smithwick.

ington hand, astronomer Jeffrey Rosendhal, who (with the assistance of a national committee of scientists and educators) laid out a concrete vision for getting science and scientists involved in education and outreach. They saw that just like a new plant form needs a supportive ecosystem to flourish, so the new emphasis on EPO would need an organizational "ecosystem" to take root properly.

Rosendhal and his task force saw that such an ecosystem could be fostered in two ways. A series of topical fora would tie together NASA missions and projects that dealt with similar subjects—such as the exploration of the Solar System. At the same time, a set of regional broker/facilitators would connect NASA's educational efforts with both formal and informal educational communities, including teacher groups, publishers, websites, community groups, museums and planetaria, book authors, etc. Both parts of the ecosystem would need to be funded adequately to reach out actively to their constituents and to proselytize for the EPO cause.

By 1997, NASA required all space-science programs, large or small, to put aside 1-2% of their total budget for education and outreach. This meant that millions of dollars became available to try new experiments and reach out to new audiences. Today, Larry Cooper, who is the acting manager of the system (now called the NASA Science Mission Directorate EPO Support Network), estimates that the space-science EPO enterprise is investing about 42 million dollars a year. While this amount may decrease as NASA tries to fulfill its many current goals, there is no question that such NASA funding represents a huge increase in the resources available to the emerging EPO profession.

In telling the story of the role of NASA's Office of Space Science (now part of the Science Mission Directorate), I don't want to minimize the activities of the National Science Foundation, the national observatories, the American Astronomical Society's Astronomy Education Board, and, of course, the ASP. All of these groups, and many others, were also busy during this same period, injecting money and new thinking into new ways of reaching the schools and the public. It was during this period, for example, that the ASP's NSF-funded Project ASTRO began to place volunteer astronomers into 4th- through 9th-grade classrooms in over a dozen regional sites around the country.

Being a More Formal Profession

Like any new profession, astronomy's EPO

Astronomer Edwin Hubble trained first as a lawyer and then pursued a Ph.D. degree in astronomy. Photo courtesy of the ASP Archives.

Astronomer Milton Humason's formal education ended in the 8th grade. Photo courtesy of the ASP Archives.

providers sometimes have more enthusiasm than training. Some have been involved for a decade or more, but others have just recently joined the ranks. Training for new people in the field is often hands-on and learn-as-you-go. There are few courses or workshops to take, and many new practitioners just make things up as they go along. Communication among people in different institutions is still catch as catch can. Indeed, "reinventing the wheel" is common: for example, half a dozen groups have over the years created basic wall charts and booklets explaining the electromagnetic spectrum without being aware of earlier work very similar to theirs.

Let's consider what makes something a profession in the United States and how professions get public respect over the years. The practitioners usually begin by organizing themselves into one or more professional organizations (think "American Bar Association"), publishing journals and magazines to keep in touch, and formulating entry requirements for the profession. These may involve formal education, apprenticeships, examinations, continuing professional development, boards that certify competence, and (very important) fancy certificates that can be put on your office wall to impress visitors. Eventually, the practitioners lobby state and federal legislatures to have laws passed that formalize the entry requirements into their profession and keep out people who don't meet those requirements. In other cases, such rules are built into the procedures for getting an advanced university degree for that field.

As times and professions evolve, the entrance rules may change and become more formal. Those who enjoy astronomical history may have read the story of how Edwin Hubble's father pressured him to become a lawyer (and not to disgrace the family by taking up astronomy.) The requirements to be a lawyer in the U. S. were a lot less formal in 1914 than they are today.

American astronomy itself has gone through the development of such procedures over the last century and a half. Astronomy researchers have an active professional society (the American Astronomical Society), founded in 1899. They have journals, such as the *Astrophysical Journal*, through which they tell each other about their work. They have Masters- and doctoral-degree programs that certify practitioners of astronomy, and apprenticeship programs (called post-doctoral fellowships, or "post-docs") that further train young astronomers with practical career-related skills. And, of course, astronomers also have a wide range of research conferences, and special-interest-group meetings, to share their results and to have a chance to talk with colleagues about mutual interests.

These processes have become much more formal in astronomy over the last half-century. It is highly unlikely that Milton Humason, a young man whose formal education stopped with the 8th grade, and who worked both as mule-driver and janitor at the Mount Wilson Observatory before being trained as an astronomical observer, could become a noted research astronomer today, as he did with the help of Edwin Hubble and others in the 1920s.

Formalizing the EPO-Provider Profession

Considering the criteria we discussed in the previous section, we see that astronomy intermediaries do not yet have many of the characteristics that define a profession.

The good news is that there is now a journal/magazine called *Astronomy Education Review*, which is publishing research on astronomy education and outreach in one central location and preserving the work of the profession for posterity. It is not a paper journal, but an electronic one, kept on the Web at *aer.noao.edu*. Articles can be posted to the site as soon as they have been refereed and edited, so the journal grows week by week (see p. 46 for a listing of new articles in the *AER*; the seventh issue is under way as I write this article in July 2005). And *Mercury* is also publishing more articles on education and outreach these days, thanks to a strong editorial hand.

There are also two respected awards in the field—the Education Prize of the American Astronomical Society and the Klumpke-Roberts Award (for astronomy popularization) of the ASP. However, these prizes often go to the "big names" in the education field and to people who have been credentialed in another field besides "EPO provider."

What is unfortunate is that many of the other elements of the profession are still missing. There is no professional organization (although the ASP is moving in this direction), no agreed-upon method of credentialing new members, and no standard curriculum for a student interested in being an EPO profession-

Ten Ways EPO Providers Can be More Professional

1 Do less P-R for your specific institution or project and more general education.

2 Learn the literature of astronomy education and don't reinvent the wheel.

3 Don't feel the pressure to create something new—find something that works and spread the technique to new audiences.

4 Plan long in advance (just as researchers do)—don't just throw something together at the last minute.

5 Coordinate with others working on similar projects—actively seek them out, make conference calls, go to meetings, etc.

6 Learn how to do research on the effectiveness of your programs and then do it (if necessary, get funding to hire a professional evaluator).

7 Publish the results of your educational and outreach programs.

8 Push your supervisor to get you more formal training for the things you want to do.

9 Join in efforts to organize the community by encouraging meetings, web-based resource databases, exchanges of personnel, more training programs, etc.

10 Encourage the funding agencies to support such efforts.

— *A. F.*

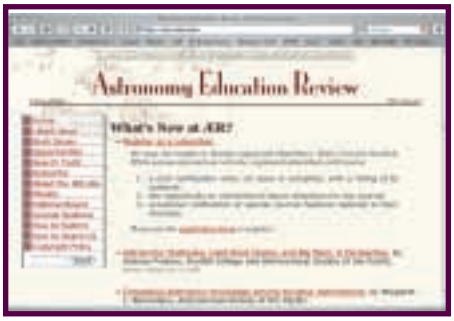
Now Director of Education & Public Outreach at the Space Science Institute in Boulder, Colorado, Cherilynn Morrow was one of the first scientists at NASA to consider the qualities of an effective EPO provider. Photo by A. Fraknoi.

Retired NASA astronomer Jeffrey Rosendhal, with the assistance of a national committee of scientists and educators, laid out a concrete vision for getting science and scientists involved in education and outreach. Photo by A. Fraknoi.

Timothy Slater, an astronomer at the University of Arizona, is Chair of the Program Organizing Committee for the 2005 ASP Meeting on the EPO Profession. Photo courtesy of the University of Arizona.

al. The field has no university degrees, few continuing-education courses, and only a minimal historical archive or community memory of what has been tried before. Indeed, few projects in astronomy education and outreach have been formally written up, and many of those that have are scattered in government reports, private newsletters, and journals astronomers never see—much of the work published prior to the *Astronomy Education Review* will be hard to retrieve in coming years. Instead, ideas in education and outreach are passed along from person to person, using photocopied sheets or rewritten activities whose original source is long forgotten.

As a result, there are currently few opportunities for EPO providers even to learn about work going on in other institutions before beginning their own work, to say nothing of giving proper credit for those whose ideas may have influenced them. Also, there is a great tendency for people in other fields (such as science research) to jump into education—with the best of intentions—and make wide-ranging suggestions without any familiarity with the existing literature.



The *Astronomy Education Review*, located at *aer.noao.edu*, is a "lively electronic compendium of research, news, resources, and opinion" for educators, EPO professionals, and anyone interested in astronomy and space-science education.

Can you imagine someone saying: "Well, I've been reading a bit about supernovae and have been thinking about them for a while. The whole field sounds like it needs a little straight-forward thought and common sense. So, while I haven't taken any courses in astrophysics, and I don't really know the supernova literature, I think I'll do supernova research with 20% of my time and show you all what's needed." Anyone who said this would be laughed out of their institution and any supernova meeting he or she attended. Yet people make just such statements regularly when it comes to education. These things are not easy to change but will be absolutely necessary to change if we want to win greater respect for this new profession.

Meetings (Past and Future)

Certainly, a key part of any profession is a regular series of meetings for the practitioners, where a significant number of them can gather, share their work (including ideas that have failed), and introduce younger people to the community. The first general EPO meeting in the U. S. was sponsored in the summer of 2002 by NASA's Office of Space Science and published as volume 319 of the ASP Conference Series. Although both the meeting and the book are heavily weighted toward NASA programs, enough people outside the NASA structure were asked to speak that the book is a nice snapshot of where things stand at the beginning of the new century. You can see people at the meeting starting to come to terms with the idea of a profession—but not quite able to formulate who belongs, how it might be organized, and what the next steps should be.

A more general EPO meeting is being sponsored by the ASP this September in Tucson. A much wider range of EPO practitioners is expected to report on their work and to present seminars and workshops for newer members of the profession. Tim Slater of the University of Arizona, a member of the ASP Board of Directors, chairs the organizing committee and deserves an enormous amount of credit for pulling together so many different threads in the fabric of a single meeting.

ASP Executive Director Michael Bennett has said that, if this meeting is a success (and with 250 pre-registrants in July, it is likely to be one), the ASP will sponsor a regular series of EPO symposia in coming years and provide more of an umbrella for practitioners to meet.

Why Do Things Need to Change?

In his 1998 Millikan Award Lecture, physics education researcher Joe Redish asked physicists to consider why physics accumulates knowledge, but physics education seems not to do so. The same could be asked for astronomy education: why do we keep re-inventing the wheel, or as physics educator Melba Phillips said, "re-inventing the flat tire"?

Redish's answer was that there is no community of physics education knowledge, with repeated and widely publicized experiments, with shared and peer-reviewed principles that are constantly tested, with publication, discussion, and extension. This is even more true for astronomy than for physics. Right now, each astronomy department, each instructor, each NASA project or center, each observatory or research lab is a separate fiefdom, with little shared information and no agreed-upon research protocols. Redish called such a situation a community of weakly interacting individuals.

Yet, as we have seen, professional societies, NASA, NSF, and the national observatories all have an interest in (and now a considerable investment in) encouraging more work in education and public outreach. Slowly but surely, a small community of educational practitioners is arising, and it could, with the right encouragement, grow into a recognized profession.

One thing that is now needed is a kind of "virtual observatory" for educational projects and materials and best practices—a shared pool of information and observations. We also need astronomy and other science departments to work much more closely with schools of education and schools of journalism on campus. We need them to

give credit and support to professors and students who express an interest in education—not just education on campus—and to recognize such efforts in promotion, tenure, and the distribution of funding. But all of us individually must do more, getting out of our usual routine and connecting more with the schools, with the media, with civic groups, and with the public.

In planning for the future, we must also understand that we may be overtaken by events beyond our control. You may have read, for example, how the new national standardized tests are likely to reduce the amount of astronomy and space science being taught in this country. With an emphasis on basics—and with a focus on biology, chemistry, and physics—it may be that "no student left behind" turns into "no astronomy left" in our nation's schools. The ongoing shortage of good science and math teachers is expected to worsen in the coming decade, and it is not clear whether our universities and colleges are prepared to meet the growing need. Who then will be there to teach or be allowed to teach that module on the cosmic microwave background or the moons of Saturn that we astronomers have so lovingly developed?

Sadly, we live in a postmodern age when it is "cool" to be ignorant of science and its method; where truth and falsehood are seen as relative values; where profit is often valued above responsibility; where the political will to address long-term problems is sorely lacking (see "Science in a Postmodern World," p. 47). There is a powerful, well-financed, anti-intellectual, anti-science movement in this country and around the world—a movement that threatens the integrity of the progress science has made in our lifetimes.

The best defense we have against this movement is outstanding, effective science education for as large a segment of our population as possible. Yet so much of our educational system is in disarray. If we allow science education in the U. S. to continue to deteriorate and fall behind, we are conceding the field to the anti-science movement as surely as if we had joined it. Given the appeal of our science, an active, well supported, and highly professional cadre of astronomy intermediaries can be one of our country's most effective weapons in this struggle. m

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