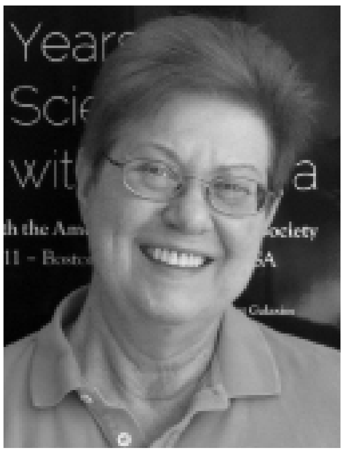
Over a Decade of Chandra EPO: How Things Have Changed… And Grown!



Do you remember film cameras and 35 mm slides? Viewgraphs? Camera-ready copy? Mosaic? These were the technologies and platforms available for public outreach when the Chandra EPO program was initiated, just before Chandra's launch in 1999. Only 12 years later it's a very different world, and the Chandra program has evolved to take advantage of emerging technologies, both for production and dissemination.

Two "foundation" decisions still underlie our approach to EPO. First, we recognized that the concept of light other than optical was relatively unknown to the general public. We made a decision to present Chandra science results in a multi-wavelength, broader science context, and to use this context as an educational tool. Our second decision was to link press results with subsequent public and education products: We use public outreach as a critical bridge between the introduction of science stories to the general public through the media and the study of fundamental science and astrophysics concepts via informal and formal education.

Electronic media were always central to achieving broad dissemination, but with the explosion of social media, and "Web 2.0" initiatives, this area becomes crucial to reaching new and younger audiences. Chandra's Sec. 508 & W3C compliant public web site serves as an online center for exploration and education, as well as a repository for all of Chandra's EPO products. A major upgrade has taken the Chandra web site to a needs-focused, user-directed, interactive multimedia experience with web applications, mobile compatibility, metadata tagging and "opt-in" RSS feeds. An "open FITS" section allows for direct public access to Chandra data and supports "open government" initiatives. The Chandra blog became broader in its reach (linked from the Christian Science Monitor, for example) and scope (such as a career-focused series on women in high-energy astrophysics, a solar-centered string of entries, etc.)

We continue to evolve our multi-media products to meet the public interest in visual products, especially high definition (HD). We initiated a series of HD video podcasts that now make up the top accessed page on our web site and have won several awards. We contribute to NASA's View Space program, sending the latest science content to over 100 museums and science centers. We have produced artist illustrations, motion graphics, and animations that are crucial for explaining complex high-energy astrophysics and making it more accessible to the media, public, and students. Collaborating with Harvard's Initiative in Innovative Computing (IIC) provided us with the tools to do 3-D mapping of supernova remnants, such as Cassiopeia A.

In addition, one of the hallmarks of Chandra's EPO program has been the creation and development, in collaboration with scientists, of over 65 unique print and multimedia products appropriate for specific age groups. Providing these materials free of charge ensures that the science from Chandra and NASA can reach diverse populations regardless of access to technology.

For IYA, Chandra EPO conceived of, designed, and implemented the "From Earth to the Universe" (FETTU) project that was displayed in about 1,000 sites in 65 countries around the world. NASA leveraged this development with a grant to create semi-permanent exhibits in Chicago's O'Hare and Atlanta's Hartsfield airports, as well as a 50-image traveling version. FETTU exhibits continue to be staged. A smaller version is being developed for use at science fairs and programs at music festivals. A "clone" is being developed with NASA's Planetary Division to celebrate the "Year of the Solar System". FETTU also created a Braille-tactile exhibit of astronomy images that were disseminated to 15 locations and two NASA programs. In recognition of the project's

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In This Issue

Welcome to issue 12 of *Spark*!

Welcome to the first all-electronic issue of Spark—as the AAS goes green, so do we. Due to Spark's new availability as an online-only document, we have made a couple changes. Spark will now come out twice a year to coincide with the Fall and Summer seasons, as opposed to the Winter and Summer AAS meetings. Also, we will not be including the AAS meeting schedule of education-related sessions. We had previously done both to make issues of Spark additionally relevant to members in attendance at meetings since this is where issues of Spark where debuted. But, not to worry, the remaining content of Spark is still relevant to all Society members interested in education issues!

We start this issue with a ten-year retrospective on Chandra EPO from Kathy Lestition. Luisa Rebull tells us about an exciting opportunity for teachers to become involved in authentic research. We have another ten-year retrospective, this one from Andy Fraknoi on the first decade of *Astronomy Education Review*. Julia Kregenow gives us some insight into ways to increase the impact of our office hours. We hear from columnist Sara Mitchell about how to "pop" our EPO. Several graduate students and undergraduates share their experiences with programs designed to increase diversity in astronomy. Mary Dussault provides some insight into evaluating science museum experiences. Emily Lakdawalla shares with us the wonders that can be created when "amateur" astronomers and art combine, while Jack Hehn gives us his views on *Prepare and Inspire*. You'll also find insights to each feature article mentioned above by our Spark columnists.

Finally, we hope you'll enjoy Adam Burgasser's book review on *Aligning for Learning*, as well as enjoy AAS Division News, pictures from the Seattle AAS meeting, and what's new in *Astronomy Education Review*.

Gina Brissenden & Jake Noel-Storr
Editors

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Over a Decade of Chandra EPO: How Things Have Changed…And Grown! continued

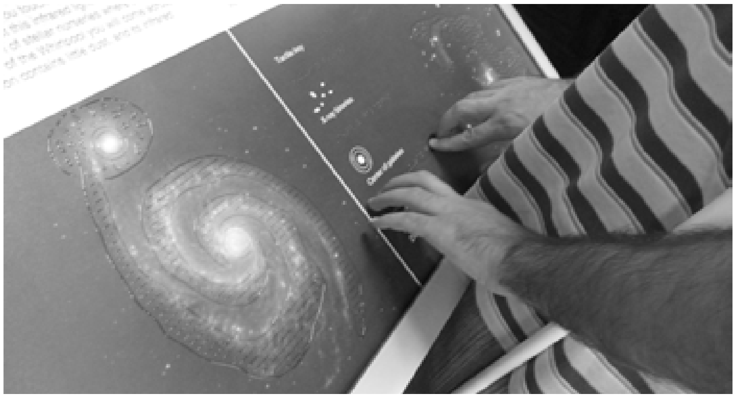



Figure 1: One of a series of traveling tactile and Braille exhibits for the blind and visually-impaired was launched at the Martin Luther King, Jr. Library in Washington, DC, July 2009. Figure 2: "From Earth to the Universe" (FETTU) project was displayed around the globe, including in St. Andrew Square, Edinburgh (shown here) in 2009.

success, FETTU was nominated by NASA and won the Manu Bhaumik award for the best IYA program.

Publicly released images are used in all aspects of our EPO program. Since no previous X-ray mission has had the angular resolution of Chandra, innovative techniques for public releases such as smoothing, upsampling, and compositing have been developed and honed as the mission has progressed. All released Chandra images have standardized metadata embedded, ensuring content is not separated when images are included in external sites. WCS inclusion has allowed Chandra images to be accessed through the US and international Virtual Observatories, Sky in Google Earth, Microsoft's World Wide Telescope and through additional immersive applications such as digital planetariums.

In conjunction with partners at SAO and the University of Otago (New Zealand), we initiated a project surveying the public's perception of multi-wavelength astronomical imagery. This study, "Aesthetics & Astronomy," (A&A) explores how viewers understand what they are seeing and the science that underlies the images. Preliminary analysis reveals new insight into the public's understanding and relationship with key elements like color, scale, and context. In 2010, funding was awarded by the competitive Smithsonian Scholarly Studies program for a second study to research reactions to the images across different platforms: web, mobile, traditional print, and large-format print.

We initiated the incorporation of Chandra and other NASA space science content into the test material for the astronomy competitions in the National Science Olympiad and we continue to collaborate on updating the content and orienting team coaches. We provide content for implementation of science programs through the Girl Scouts and 4-H Clubs. We develop education resources based on NASA space science materials, and provide professional development (PD) opportunities for teachers and teacher leaders. Topics range from basic concepts (the EMS) to materials incorporating specific science results requested by educators and known to engage students (e.g. black holes, SNRs).

While the majority of workshop content and materials are most applicable to middle or high school grades, some (Stellar evolution, "Chandra-Ed") are suitable for use in community colleges and introductory undergraduate education. A key accomplishment is enabling access and tools for student engagement with Chandra science data. We have developed an on-line program ("Chandra-Ed") enabling student access to Chandra (and other FITS) data sets accompanied by structured activities for training purposes. We co-sponsor the Rutgers (University) Astrophysics Institute (RAI) that trains approximately 20 high school students, 10 teachers, as well as 4-6 pre-service teachers per year in an intensive summer program followed by year-long mentoring.

That's a surf through highlights from the last 12 years. Our EPO team is enthusiastically looking forward to exciting work in the future.

Kathy Lestition, Chandra EPO Coordinator

K-12 Astronomy Education

Columnist: Wil van der Veen, Raritan Valley Community College

For this issue of *Spark's* K-12 Astronomy Education Feature Article, Luisa Rebull (Caltech) shares some of the successes of the NASA/IPAC Teacher Archive Research Program (NITARP). In her article she refers to the need for a society in which more adults understand science. That means an understanding of not only the content, which is the focus of most science courses, but also of how science works. The NITARP program attempts to address this situation by having teachers experience the process of scientific research. While this is definitely a powerful way to increase people's understanding of science as a practice, there is more that we can and should do as a scientific community.

The new National Science Education Standards will place an increased emphasis on integrating the practices and the nature of science with the learning of science content (see *Spark, Issue 11*, January 2011). This is similar to how scientists learn about the world as they engage in scientific research. It is important that we provide educators at the K-12 and college levels with an understanding of the practices and nature of science, as well as the tools to have their students reflect on it. Science education research has shown that simply having students or teachers *"do science does not equate to teaching about the nature of science; even if these activities involve students in high levels of inquiry and experimentation"* (Bell, 2008). This paper published by the National Geographic Society summarizes some key ideas about the nature of science and our current understanding of how to teach it effectively. The paper (Bell: 2008, *Teaching the Nature of Science: Three Critical Questions)* can be downloaded at *www.ngsp.com/Portals/0/downloads/SCL22-0449A_AM_Bell.pdf*

NASA/IPAC Teacher Archive Research Program (NITARP): Getting Teachers Involved In Authentic Astronomy Research

Luisa Rebull, Spitzer Science Center, Caltech/JPL

How many times have you gotten a question from the general public, or read a news story, and concluded that "they just don't understand how real science works"? In order to have more people understand how science works, we need more people to experience the process of scientific research. Since 2004, we have done exactly this. As of 2009, NITARP (NASA/IPAC Teacher Archive Research Program) is the successor to the highly successful Spitzer Teacher Program and is an effective and inspiring way to get authentic research experiences into classrooms across the US. We partner professional astronomers with (primarily) high school teachers, carry out an original research project, and present the results at a Winter AAS meeting. The educators incorporate the experience into their classrooms and share their experience with other teachers.

This program, to the best of our knowledge, is unique in the following two important ways: (1) each team does *original* research using *real astronomical data*, not canned labs or reproductions of previously done research; (2) each team *writes up the results* of their research and presents it as a science poster at an AAS meeting. Each team also presents the educational results of their experience in a companion education poster. If the results warrant, the teachers are included as co-authors in a scientific publication resulting from their project.

At the Seattle AAS meeting this past January, we had nearly 60 NITARP-affiliated attendees— about 2% of the meeting! A dozen educators started up with their teams for 2011, and the rest were the 2010 teachers and students finishing up and presenting their results in a total of **NINE**(!) posters. The 2010 teams discovered things in four different fields: 19 entirely new young stars, ring-like structures in a circumstellar disk, stellar variables serendipitously observed in exoplanet observations, and correlations between IR and UV properties of active galactic nuclei. The 2011 teams are currently writing their proposals; the teams will use data from a variety of sources, including Spitzer and Kepler. Look for their results in Austin in January 2012!

The project participants get three trips, with all reasonable travel expenses paid. The educators first come to a Winter AAS meeting, then they, with up to two students per teacher, come out to visit us at Caltech for 3 days in the Summer to work on their data. Finally they can bring up to two students to present their results at the following Winter AAS meeting. The groups work remotely in the intervening months—telecons and wikis help the participants collaborate.

Our educators are primarily high school teachers, though we have had 8th grade and community college instructors as well. This year, we are including educators from more unusual venues, such as the amateur astronomical community—these non-traditional educators often reach thousands of people per year, and provide us with another avenue to convey the excitement of real research to the general public.

Here are some selected quotes from participants (teachers and students) attending the Seattle AAS; many more are on our website:

- [...]it invigorated me to become part of the greater message, which is the story of space and ground based observatories[…] Never in the history of this great science has so much data […]been available to not just the scientific community but the general public as well. All one has to do is just ask!
- I always thought just from programs on tv and in the classroom that astronomy was more or less completely figured out. Learning that it isn't is pretty exciting.
- [One of the other teachers with whom I've been working now] sees herself as being able to teach science, [...] so it seems that becoming empowered in the language and the nature of inquiry and investigation was also life changing for our teacher participants.
- Being there with my students was the most amazingly cool experience. I saw [them] explode in their willingness to ask questions and express an opinion. [...]I was totally amazed by how their attendance made them reflective about the year and enthusiastic about science.
- EVERYTHING had a different flavor this year. [...] I experienced everything through the lens of the research project of the past year. The entire experience was in context. [...] When I look at how the intellectual process changed over the last year, I imagine it going from a diffuse look at research and the entire conference experience to the extreme focus on our own project during the year and finally reaching outward again in Seattle to incorporate new information and understandings. Returning to AAS made the experience complete.

Come play with us! We select educators from a nationwide application process; application forms are available in May and due in September. Please encourage any grade 8-13 teachers you know to apply! If you are a 'non-traditional educator' and want to join us (or you know someone like this), make your case in your application! Convince us that you will leverage your experience in an interesting and innovative way. We do require some baseline astronomy knowledge because we have a lot to accomplish in just a calendar year. If you already have an astronomy PhD, you already know how astronomy research works, so we'd love to talk to you about mentoring or co-mentoring a team! We also can help you with outreach for your mission/telescope. If you have as little as $50K, you can subsidize a team. ***Please e-mail us at nitarp – at – ipac.caltech.edu with any questions or to be notified when applications are available.***

Astronomy Education Research

Columnist: Ed Prather, Univ. of Arizona

I just finished reading the letter from my provost here at the University of Arizona which gives me final confirmation of tenure within the astronomy department and Steward Observatory. To earn tenure within a powerhouse astronomy department like Steward Observatory requires that one maintain a rigorous peer-reviewed publication record. As a researcher whose scholarly activity is astronomy education research, I have been very fortunate that the online journal *Astronomy Education Review* (AER) exists. I owe a tremendous debt of gratitude to the founders of this much needed journal as a significant amount of my work has been published in AER. Having a central publication that brings the results of astronomy education research to the greater astronomy community is essential to advancing the teaching and learning of our science.

In this edition of the *Astronomy Education Research* feature section we will learn first hand from one of the AER founders, Andy Fraknoi (Foothill College), about how the journal was born and how it has prospered.

Celebrating the 10th Anniversary of *Astronomy Education Review*: How The Journal Began

Andrew Fraknoi, Foothill College

This October will be the 10th anniversary of the publication of the first paper in the online journal and magazine, *Astronomy Education Review* (AER). But just as the birth of the readers of this column required some activities beforehand, so the debut of AER was preceded by a period of uncertain gestation. By the 1990's, the practice of astronomy education research had moved from being the domain of the occasional education professor to a bourgeoning field within astronomy. With more education papers and symposia offered at meetings of both the Astronomical Society of the Pacific (ASP) and the American Astronomical Society (AAS), practitioners of this kind of research began slowly to see themselves as part of a new sub-profession within the astronomical community.

However, papers and articles about education in astronomy were scattered among a variety of magazines and journals, such as *Mercury* (the popular-level magazine of the ASP), *The Planetarian* (the magazine of the International Planetarium Society), *The American Journal of Physics, The Journal of Research in Science Teaching,* and a number of others. Many of these pieces were not being read by those actually engaged in astronomy education—whether in a formal classroom or in an informal setting. As a result, several of us began harboring the dream of a publication devoted to astronomy education and outreach.

Eventually, a sub-committee was appointed by the AAS Astronomy Education Board to look into the matter, first chaired by Juan Burciaga and then by me. The group met over several years, formulated plans, and submitted ideas for such a journal to various organizations, including the AAS and the ASP as well as NASA. But the wave of enthusiasm always broke on the same rocky crag of reality—who would pay for the costs associated with setting up and running a journal whose audience was—at least at first—likely to be small in number and poor in resources? The last formal meeting of this informal committee took place at the Atlanta AAS meeting in January 2000, where we discussed a more detailed framework for the journal, but again found no funding source for the project.

The hero who "rode to the rescue" was Sidney Wolff, then recently retired as the Director of the National Optical Astronomy Observatories (NOAO). I got to know Sidney when she was on the Board (and then President) of the ASP and I was the Society's Executive Director. Later, Sidney and David Morrison invited me to join them in updating George Abell's line of textbooks and in starting one of our own. I was in Sidney's office in Tucson one day, soon after she had become a "civilian" after many years of being an administrator, and our conversation turned to what we each wanted to do in the future.

I recounted to Sidney how much I really wanted to help establish a journal/magazine for astronomy education, but that no one with resources seemed to want to take on the task. To my surprise, Sidney said something like, "Well, that sounds interesting. Why don't we do it together and get NOAO to take it on." And once Sidney signed on, the barriers just tumbled down.

Two key decisions we made were to publish the journal *online only* (and let readers print it out) and to make it available free of charge, so that no apparatus needed to be set up to collect subscription fees. This meant that—after the initial period of programming the journal's web site—the infrastructure required to maintain the journal was relatively modest. Very generously, NOAO agreed to foot the bill for setting things up.

I put together a plan that detailed the sections of the journal and what the website needed to become operational and Sidney got some of the wonderful programmers at NOAO to make it happen. Knowing that the number of true research papers would be quite small at the beginning, we modeled the publication more after *Science* or *Nature,* rather than *The Astrophysical Journal.* In addition to research results, we wrote and welcomed editorials and op-ed pieces, brief reports on innovative techniques, book reviews and announcements, resource guides, and dissertation abstracts. To maintain the kind of standards that we knew would be needed to have the journal win the acceptance of the community (and tenure and salary advancement committees), we early on decided that *all* contributions to the journal would be peer refereed.

At first, AER became part of Sidney's work at NOAO and I volunteered my time, but eventually we applied for and received a grant from the Space Science Division (now the Science Mission Directorate) at NASA to help us with some of the expenses—particularly to hire a copy editor to help with some of the most intensive work of editing, particularly when the authors were from countries where a language other than English was used or (equally hard for our readers) authors used more educational jargon than was needed.

To be sure that we had the benefit of the advice of a wide range of the community of potential contributors, referees and users, we formed two groups to help us. A Board of Editors would assist with the rules for maintaining high standards, with refereeing and suggesting outside referees, and with periodic reviews of how we were doing. A Council of Advisors would help us with "business and operations" issues, with publicity for the new enterprise, and more general advice about online publishing, which was far less common in 2001 than it is today.

By July 2001, we were ready to begin asking for papers and ready to hold a focus group at the St. Paul meeting of the ASP on making the journal a reality. And by that October, the journal published its first set of contributions using the NOAO website.

When Sidney announced her retirement from NOAO and the journal, a new home had to be found for *Astronomy Education Review.* After some discussions and the strong recommendation of its Astronomy Education Board, the AAS decided to take on publication of the journal starting in 2009, and to use the American Institute of Physics *Scitation* platform to give it a more professional look, archive, and functionality. In 2010, Tom Hockey of the Univ. of Northern Iowa became the new Editor-in-Chief, while I remain as Senior Editorial Advisor. Judy Johnson of the AAS serves as Managing Editor and works closely with the staff at AIP. The web address for AER is: http://aer.aas.org

We have begun the 10th volume of the journal in 2011and continue to have a steady stream of good papers and articles flowing in to our email address at: aer@aas.org from around the country and around the world. Perhaps your piece will be the next one we receive.

Teaching Astro 101

Columnist: Danielle L. Martino, Santiago Canyon College

In general, a physical science class is perceived by the undergraduate student as "hard," a "filler class," or "something I need to take." Of all the physical sciences, the introductory astronomy classes are generally seen as classes to learn about the constellations, look at pretty pictures, or learn about the horoscope. Students are often surprised when they realize that Newton's Laws, Kepler's Laws and the Universal Law of Gravitation are at the heart of the subject and they have to work to learn the material. Teaching the nature of science in an Asto 101 course is often challenging in the 50-75 minutes a couple days a week we instructors have.

While we encourage, through many means, students coming to office hours, many office hours are spent with no students showing up, allowing us to catch up on grading or write out next lectures, or we have too many students to juggle in one tiny space. Our feature article on Teaching Astro 101 comes from Julia Kregenow of Pennsylvania State University, who found a way to overcome some of these obstacles in helping students understand the nature of astronomy and making the most of office hours. Julia has worked diligently to develop *The Astronomy Learning Center* (TALC) at Penn State. TALC is a supplemental instruction environment, where students become the teacher and faculty and TAs are truly a "guide on the side."

Reinventing & Revitalizing Office Hours: What Would Socrates Do?

Julia Kregenow, Penn State

When I was a graduate student at UC Berkeley, I really liked the alternative "office hours" program for Astro 101 students that my fellow graduate student, John Asher Johnson, and I started back in 2001 called The Astronomy Learning Center (TALC). John's original motivation to start TALC was to help more students more effectively than the traditional serial approach allowed. By helping groups of students instead of individuals, he could multiply his instructional power. Over the years I noticed several other pedagogical principles that made TALC successful:

- Students learn better by doing a problem than by watching someone do it for them.
- Students can often help each other more effectively than a professor can help them.
- Articulating and explaining a concept solidifies and deepens a student's understanding of it.

I was so impressed with the TALC program at UC Berkeley that when I became an instructor at Penn State, we recreated the program here.

Instead of the traditional 1-on-1 office hours instruction where professors and TAs reprise bits of lecture and show students how to solve problems, we put students in charge. At TALC, students work with each other in small groups and solve their homework problems together at the chalkboards. TAs and professors observe and intervene as little as possible—only when necessary. When students are stuck and really do need help, the goal of the instructor is to engage the group in a Socratic dialogue, asking probing questions to find out where they are stuck and help them move forward. This is a difficult task for instructors, harder than lecturing, and doesn't come naturally for most of us who are used to just giving the answer when we know it. It's hard to withhold an answer when your instinct is to give it AND the student is begging for it. To prepare our TAs for this, we either hold a 1-2 hour training session at the beginning of the year before they ever set foot in TALC, or have them start by pairing up with an experienced TALC instructor to observe and be mentored before setting out on their own. Ideally, we would do both. Training and practice is crucial because it instructs TAs in subtle implementation details, such as leaving a group as soon as it's moving again so they don't become reliant on you, recognizing and engaging a non-participating group member, or recognizing and using to your advantage a dominant group member.

Here are THE RULES OF TALC, posted on the wall in big bold type:

1. **Teachers don't give out answers. We will help you figure out the answers.**
2. **Teachers won't look at your paper. All work should be done on the boards.**
3. **Teachers won't write on the board. Students write; teachers erase.**
4. **Students working at a board and in groups will receive priority assistance.**
5. **NO COPYING the work of others.**
6. **Help tax: if you receive help on a problem, you may be asked later to help your peers on that problem.**
7. **If teachers are busy, ask your fellow students for help!**

NOTICE:

- **No pens or pencils allowed**
- **All work is done at the board**
- **Boards will be frequently erased**

These "rules" may seem overly strict, but…

These notices let students know what to expect, so they are not surprised when a TA behaves accordingly. (The last three are important for avoiding copying.) TAs report that having these rules posted makes it much easier to enforce them. They can just point at the wall and say "Sorry, that's the rule."

Implementing TALC is a lot of work. It requires training TAs and instructors, regular access to a room lined with boards, 2 or more hours of weekly staffing, and buy-in by professors to advertise and sincerely encourage students to go. But the rewards make it worthwhile: As students recognize its utility and word spreads, attendance will exceed that of office hours. TALC is currently drawing over five times as many students as traditional office hours, so it definitely meets John's original goal of helping more students. Students who attend, both strong and weak, will perform better on their homework and have increased understanding. I also believe the training the TAs are receiving is vital to their own professional development. Whether they become educators or other non-academic professionals, they will need to learn how to interact and communicate with a non-technical audience.

When I walk into the TALC room and I see a group of four students all at the board engrossed, gesticulating and talking over one another about a problem, and a TA standing back and monitoring three such groups, I'm thrilled. Now that I have seen how much more effective TALC is than my traditional office hours, I would feel guilty not providing this resource for my students.

Astronomy in Unexpected Places: Pop Culture and *The Big Bang Theory*

Columnist: Sara Mitchell, Goddard Space Flight Center

As I've written many times in my column in Spark's feature section *Astronomy in Unexpected Places*, relevance is absolutely crucial to hooking your audience. I try to look at every education and outreach project or product from the perspective of an audience member, and ask, "Why should I care?" This is the question that your audience may be asking, even just in their heads, and you should think about it in the developmental stages of any content. It can be very difficult to engage the audience without making a personal connection to the content you're providing, especially when your audience isn't particularly science-interested. This is why I look for real-world connections, human stories, technology links, and other angles that let me respond, "*This* is why you should care!"

Some content makes it easy to find that connection and make it relevant to the audience. In my experience, relevance seems to decrease with distance. The closer an object (or concept) is to Earth, the more likely it is that we've explored it and that it has a direct impact on or connection with mankind. But as you start talking about more distant things in astronomy—other stars, other galaxies, distant black holes, extrasolar planets—that straightforward connection to *us* gets weaker. Sometimes I'm left scratching my head, wondering, "Where's the hook?"

How about… popular culture? There's plenty of astronomy in pop culture, and not just in science fiction. There are candy bars and cars named after various astronomical objects, songs about space travel and exploration, and plenty of television shows and movies that portray astronomers and astronomy (with varying degrees of realism). It's out there, and you don't even have to look very hard for it. But the important question is: How can you take advantage of it?

I produce NASA Blueshift, a project out of Goddard's Astrophysics Science Division that provides a "behind the scenes" look at what's going on in astrophysics through blogs, podcasts, social media, and more. Last summer, we were interviewing Britt Griswold, the designer of an educational beach ball imprinted with data from the Wilkinson Microwave Anisotropy Probe (WMAP). In the interview, he mentioned that the beach ball had been spotted on the set of the CBS sitcom *The Big Bang Theory*—it's in the background of one of the main sets, and it's been in nearly every episode for the past four seasons. We contacted Co-Creator/Executive Producer, Bill Prady, for a photo we could use of the ball on the set, and we got a whole lot more than we'd expected—a visit to the set to take the photographs ourselves, and a podcast interview with Bill about the science in the show and what they do to get it right!

When we'd started working on the interview about the beach ball, we were just going to use it as a fun little story about an unusual educational product. Thanks to the pop culture connection, it quickly became something much larger—a series of blog posts, a podcast, and a NASA web feature that was picked up by news outlets worldwide. Demand for the

continued on next page

Astronomy in Unexpected Places: Pop Culture and The Big Bang Theory continued

WMAP beach ball grew, too, and it wasn't just because the ball was sitting behind the couch in Sheldon's and Leonard's apartment. The show had helped us raise awareness of the product and the science behind it, and when we ran a giveaway that asked what people would do with a ball of their own, their ideas were surprisingly scientific. "I'd also use it as an educational aid, but with an eye towards disinterested kids. Toss 'em the ball and tell them they are holding the universe in their hands," offered one entrant. A clever product and a pop culture connection made something that might not grab an audience—the cosmic microwave background—intriguing and engaging.

The Big Bang Theory has more to offer than just a beach ball. The sets are filled with astronomy goodies, and we brought the production staff even more when we visited the set. Each episode has lots of space-themed items in the background—Hubble images, a model of the James Webb Space Telescope, mission stickers on the fridge, posters from the Solar Dynamics Observatory, and more. Then there's the show's scientific content, which is carefully crafted to be relevant, accurate, and funny. The science is guided and vetted by astrophysicist David Saltzberg (UCLA), who writes about each episode's science in his own blog, *The Big Blog Theory*. Whether it's a malfunctioning space toilet, observations at the Keck Observatory, or the stars in our neighborhood, the science content of the show is also an attention-getting springboard to educational content.

Our experiences with *The Big Bang Theory* are only an example—you can utilize a variety of pop culture sources to give your content a fun and engaging angle. If pop culture gets the science right, you can reference it. If the science is wrong, that can be just as much fun, because everyone loves a good debunking! Here's your chance to talk about why the world isn't going to end in 2012, or why you shouldn't have heard the Death Star explode (remember, "In space, no one can hear you scream!").

There are downsides to utilizing astronomy in popular culture, of course. When the science is wrong, it's wrong in front of millions of people (who mostly don't know any better), which reinforces misconceptions. And a pop culture hook is no replacement for quality educational content—it's just a way to get your foot in the door. Then you have to do the rest.

Figure 1: Sara Mitchell, Sarah Eyermann, and Maggie Masetti of NASA Blueshift pose with the WMAP beach ball on the set of the CBS show The Big Bang Theory*. Figure 2: The set of* The Big Bang Theory *features many astronomy outreach items—can you spot the ones pictured here?*

Astronomy Undergraduate and Graduate Student Education & Research

Columnist: Alexander Rudolph, Cal Poly Pomona

Welcome to the feature section on *Astronomy Undergraduate and Graduate Student Education and Research* in which we continue our focus on programs designed to increase the number of minority and female students pursuing a B.S. or Ph.D. in astronomy or related fields. This issue's feature article highlights students from two graduate programs: the Fisk-Vanderbilt Masters-to-PhD Bridge Program and the Columbia University Bridge to PhD Program in the Natural Sciences.

The Fisk-Vanderbilt Masters-to-PhD Bridge Program is a set of research-based partnerships linking Vanderbilt with neighboring Historically Black Colleges and Universities. The key innovation of the program is its leveraging of the Master's degree as a critical juncture in the PhD pipeline for underrepresented minorities. Since its inception in 2004, the program has admitted 43 students, 38 of them underrepresented minorities (all US citizens), 55% female, with a retention rate of 92%. In 2011, Vanderbilt will become the top research university to award the PhD to underrepresented minorities in astronomy and physics. The program is funded by the Partnerships in Astronomy and Astrophysics Research and Education (PAARE) program of the NSF.

The Columbia University Bridge to Ph.D. Program in the Natural Sciences prepares talented post-baccalaureate scholars from groups that have been historically underrepresented in the natural sciences for the transition to graduate school. Bridge scholars are hired as full-time Columbia University research assistants for up to two years. They conduct research under the supervision and mentorship of faculty members, postdoctoral researchers, and graduate students. The Program's alumni have gone on to PhD programs in astronomy, biology, and psychology at institutions such as the University of Michigan, Brandeis University, Johns Hopkins University—and Columbia's Graduate School of Arts & Sciences. The program has received funding from the Astronomy Division of the NSF to expand this successful program over the next three years.

Creating Diversity: Students Share Their Experiences with Programs Promoting Change (Part II)

Fisk-Vanderbilt Masters-to-PhD Bridge Program

The Fisk-Vanderbilt Bridge program has given me the exposure to learn what life is like as a top-level astrophysicist. Throughout grade school, I never imagined that I would aspire towards a scientific career. In turn, I felt as though my entire undergraduate career at the University of Hawai'i was playing catch-up to my peer physicists. However, I persevered due to my insatiable curiosity about the universe.

When I heard about the Bridge program, I took advantage of this post-baccalaureate option at a pivotal point in my life. I have combined my personality with the Bridge program resources to establish my scientific network. For example, I had opportunities to conduct research at world-class domestic and international facilities such as CalTech, Exeter, Cambridge and the European Space Agency. As a result, I made very strong connections with prominent figures whose invaluable advice has been instrumental as I design my own path. By learning about the breadth of successful careers, it has reinforced my desire to pursue a PhD. As I continue to grow I have realized that becoming a part of this program was necessary for my development.

Brittany Kamai, Vanderbilt Univ. (Fisk Univ. alum)

Fisk-Vanderbilt Masters-to-PhD Bridge Program

I am indebted to the Fisk-Vanderbilt Bridge Program for providing me not only with a foundational education in physics and astronomy, but also the opportunity to be a leader among my peers, a youth mentor in the Nashville community, and a collaborator with esteemed astronomers nationwide. Through the Bridge Program, I have had a chance to provide outreach in the sciences in many capacities by working with the Fisk-Vanderbilt Road Show traveling planetarium program and the Vanderbilt Scientist in the Classroom program, both of which benefit schools with underrepresented minority populations. The Bridge Program has connected me to research collaborations at Harvard University, The Space Telescope Science Institute (STScI) and with NASA's Goddard Space Flight Center through the support of NASA's Jenkins Pre-Doctoral Fellowship Program (JPFP) and the Graduate Student Researchers Program (GSRP). If not for the support and opportunities provided by Dr. Keivan Stassun and the Bridge faculty at Fisk and Vanderbilt, I would not be on the verge of a successful future in astronomy as I am today.

Thomson LeBlanc, Vanderbilt Univ.

Columbia University Bridge to PhD Program in the Natural Sciences

I entered college knowing I wanted to major in astronomy. I took several physics and astronomy classes, participated in REUs, but I was hesitant about going to graduate school. I didn't know what to expect and I was not confident enough in my skills. This hesitation led me to pursue engineering but I quickly realized astronomy was my true passion. I applied to the Bridge to Ph.D. Program at Columbia University to get a real sense of graduate school and to improve my preparation. Here, I had the opportunity to take various grad level classes, which vastly improved my skills. Doing research fulltime was challenging, but in the end, I learned how to take ownership of my project and manage my time wisely, two crucial skills needed in grad school. At the end of the program, I was sure I wanted to go to graduate school to research the role of gas in galaxy evolution and, if possible, stay at Columbia. Things worked out and I am still studying galaxies!

Ximena Fernandez, Columbia Univ.

Columbia University Bridge to PhD Program in the Natural Sciences

My involvement in the Columbia Bridge to PhD Program solidified my desire to pursue a PhD in astrophysics. Beforehand, I was still wavering between that path and the path into the work force. The Bridge Program provided me with what I like to call an introduction to grad life: one class per semester, fulltime research, and immersion into the local grad life. My particular research project served as a small introduction into the phenomena that I am now fairly certain that I will continue to study for the rest of my graduate career: degenerate matter stars. Because I was responsible for only a small portion of graduate student obligations, I was able to dedicate large swaths of time into background reading and creating a strong foundation for research that has become very dear to me. Finally, the flexibility of the tenure of the Bridge Program allowed me to apply to graduate school without worry and to seek out programs that would best suit me, as opposed to the typical method of applying to many and hoping for a few.

Nicholas Hunt-Walker, Univ. of Washington

Astronomy Education in Planetaria and Science Centers

Columnist: Lindsay Bartolone, Adler Planetarium

I have had the pleasure of working with Mary Dussault on a number of projects over the years and they have been fantastic experiences for myself as well as for the audiences they served. At the January 2011 AAS meeting, I learned of the project she describes in our feature article, and I was particularly struck by the innovative uses of technology, exhibit design and evaluation. It inspired me to think about how evaluation of a program or project can be built into the experience in a way that is invisible and entertaining to the participant. I would like to encourage more programs to think creatively about incorporating evaluation into their projects, and to make use of the technology that more and more of our audiences use everyday.

Creating Black Hole Explorers

Mary Dussault, Harvard-Smithsonian, CfA

Is it possible to create "Black Hole Explorers" out of museum visitors who may have only fleeting familiarity with this astrophysics frontier? For the past several years this question has occupied a significant chunk of my professional life as a science educator. The gravitational center of this investigation is a 2500 square foot traveling exhibition, *Black Holes: Space Warps & Time Twists*. It premiered in Boston in 2009, and will opened in June at the *Exploreum* in Mobile, Alabama.

Designing for Exploration

By definition, an exhibition on black holes takes visitors into unfamiliar territory. To make current research on black holes accessible and meaningful to broad audiences, we experimented with the use of networked exhibit technology to personalize the experience and support visitors in becoming Black Hole Explorers.

Visitors entering the exhibition choose a nickname, a digital image or avatar, and print out their own bar-coded "Black Holes Explorer's Card." Throughout the exhibit, they scan the card to collect and record images, movies, their own predictions and conclusions, and other black hole artifacts. This digital database of personal discoveries grows as visitors navigate through the gallery, and an automated web-content authoring system creates a personalized online journal of their experience that they can access at home.

Our Explorer's Card system was intended to enhance visitor motivation and learning by a) promoting active engagement with scientific practice; b) increasing the personal significance of the material presented within the exhibition; c) providing visitors with repeated opportunities to reflect upon the astronomical evidence for black holes; and d) supporting continued learning beyond the museum visit. A full walk-through of the exhibition is available at: http://www.BlackHolesExhibit.org/ATE_walk_through/BH_walk_through.aspx

The Explorer's Card system, however, definitely pushed the limits of what was technically feasible, particularly due to the project's unique requirements as a traveling exhibition. (Note to self: in the future, you might want to think twice about a project that requires the simultaneous public launches of 1) an exhibition that needs to be robust, self-contained, and reliable without onsite trained technical support; *and* 2) a content-rich database-driven web site that depends upon the seamless operation of the aforementioned exhibition!)

Measuring Results

So *are* we succeeding in creating Black Hole Explorers out of unsuspecting museum visitors? The networked exhibit technology itself provides a rich source of embedded evaluation data to help us answer that question. The Explorer's Card system captures the duration and depth of visitors' participation at each station and a vast database of artifacts that visitors have created. In addition, the

continued on next page

Creating Black Hole Explorers continued

first and last interactive exhibits within the gallery each present visitors with a single random multiple-choice survey question from a bank of 25 items, thereby providing a quasi-experimental source of pre- and post-visit responses.

Here are just a few of our results, compiled both from the traditional summative evaluation conducted by Goodman Research Group (now available at informalscience.org), and from our ongoing analysis of the rapidly accreting supermassive visitor database:

Visitors enjoy creating and personalizing their own bar-coded Black Hole Explorer's Cards to use throughout the exhibition—These young visitors have collected a bunch!

Surprising Findings:

- Despite the challenging subject matter, the exhibition appears to be a particularly successful in reaching visitors ages 12 and under, who comprise nearly 2/3 of persistent card-users.

- The 60 seconds it takes to personally choose a nickname and photo appear to make all the difference in motivating thorough exhibit-use, as students who are given pre-printed Explorer's Cards with pre-selected nicknames and images demonstrate significantly less engagement.

Promising Findings:

- From the GRG report: *[The exhibition] is associated with multiple positive visitor outcomes such as visitors' enjoyment of the exhibition, gains in their knowledge about black holes and the scientific methods used to understand black holes, an increase in their interest in the phenomenon of black holes, and positive changes in their attitudes toward science and scientific fields of study such as astronomy."*

- Visitors who use an Explorer's Card spend nearly *twice* as much time exploring the exhibition as non-card users and show evidence of significantly higher enjoyment and learning outcomes.

Finding to Follow-Up On:

- Overall, ten percent of Explorer's Card users visit their personal web journal, a high "take-up rate" among projects similar to this, but a rate that does prompt questions about better linking the physical exhibit to later reflection.

Over the next year, I will be diving deeper into the *Black Holes* data analysis to work on papers and publications—let's hope I escape its pull to see you at next January's AAS meeting!

Black Holes *was developed by the Harvard-Smithsonian Center for Astrophysics with funding from the National Science Foundation and NASA.*

Web 2.0 Enabled Astronomy Education

Columnist: Pamela L. Gay, Southern Illinois Univ., Edwardsville

Growing up I always found the planet Mercury to be a disappointment. The thing is, it was never really Mercury's fault. My eyes aren't that good, and with just the wrong amount of astigmatism, I could just never find this little planet in the twilight sky. While a telescope brought it into focus it was rarely more than a twinkling smudge in too many air masses, and even a crescent phase Mercury disappointed after having seen a crescent Venus. While I once thought, as a child, there had to be some great and inspiring NASA image of Mercury—something to make it rival a moon of Saturn or the surface of Mars—I quickly learned that even early NASA imagery did not provide me with the "wow factor" I had anticipated. In those 1980's days, the cornerstone images of Mercury were patchworks pieced together out of Mariner 10 images. The frames were all at slightly different exposures and they blended together poorly, making Mercury look like some kid's last-minute art project. Mercury was just destined, due to bad circumstances, to be blah.

But then one day I got a new view of Mercury thanks to Philosopher Ted Stryk, a professor at Roane State Community College in Oak Ridge, Tennessee. He didn't talk me into a new Zen way of seeing Mercury, or in any other way change my philosophical view on Mercury. He simply, in his spare time, created the most amazing images of Mercury I had ever seen. In his spare time, he had learned to download (and sometimes hunt down on tape and get someone else to upload and download) original NASA images from early spacecrafts. One of his many projects was to reprocess the original Mariner 10 images using modern software that can effectively adjust contrast and color balance to compensate for exposure variations. What he did was visually amazing, and scientifically allowed folks for the first time to study subtle albedo variations on the planet closest to the Sun. It was a thing of beauty and of science.

Ted is just one of hundreds of amateur image processors. Some like to do movies, and others focus on creating 3-D landscapes. Together, they are a vast wealth of information, and some of them, as Emily discusses in her article, are helping NASA better understand existing data while working to plan the Kodak moments of tomorrow. Doug Ellison helped bring many of these passionate image manipulators together in the UnmannedSpaceflight.org forums, a place where anyone can learn and get involved. Thanks to the amazing work he did, including fly-overs of Mars that can make you motion sick, Doug earned a position at NASA's JPL where he works on "Eyes on the Skies." I stand back in awe at what these people do, no PhD required, to share and showcase the beauty that is NASA space imagery—even making originally uninspiring images of Mercury jaw-droppingly beautiful.

http://nssdc.gsfc.nasa.gov/photo_gallery/photogallery-mercury.html
http://planetimages.blogspot.com/2009/09/mariner-10-at-mercury.html

Through the Eyes of an "Amateur": Art Meets Astronomy

Emily Lakdawalla, The Planetary Society

For the past five years I've been helping with the development of an exciting new way for space enthusiasts to become involved in solar system exploration: amateur image processing. Amateurs eagerly await the latest images from space missions and ask: "What would it look like if I were there?" Or "How can I relate this alien landscape to something that I know?" And with great skill and artistic talent, these "amateurs" often produce vistas of stunning beauty and illustrative power.

To explain who these people are and why they're important, let me step back a bit. Possibly the greatest discovery I made while attending graduate school had nothing to do with my research: it was the Planetary Data Center, just one floor above my office, lined with cabinet upon cabinet of enormous photographic prints and CDs packed with image data returned from all of NASA's planetary missions. Until my first visit there, I had no idea of the riches of imagery present in our national archives or that all those data were, technically, freely available to the public. But most people couldn't access the archives. Slow dial-up internet connections precluded free and easy download of much data, and even those few laypeople who purchased CDs from the National Space Science Data Center or had access to a bricks-and-mortar Planetary Data Center had to confront difficult technical challenges of learning how to open the arcanely formatted data on home computers that usually weren't up to the task of handling large images.

What a change a decade has made. All these barriers impeding public access to space image data have fallen. High-speed Internet access means that Gigabit-sized images can be downloaded painlessly. Millions of people have home computers capable of effortlessly processing large data sets, and the digital photography revolution means that many of those people have at least a basic understanding of digital images and how to improve their appearance through judicious processing. Several missions, notably the Mars

continued on next page

Through the Eyes of an "Amateur": Art Meets Astronomy continued

Exploration Rovers, Cassini, New Horizons, and Phoenix, have begun publishing JPEG or PNG-formatted versions of their image data to the Web almost as soon as the bits arrive on Earth, making the learning curve gentler for neophytes. And the establishment of online communities and the "Web 2.0" revolution with its elevation of user-generated content has enabled these people to share their knowledge and their work with each other, and enjoy together the thrill of exploring strange worlds through the daily image downlinks from distant spacecraft. One particularly productive community can be found at unmannedspaceflight.com, an online forum with more than 5,000 members from around the world.

By far the most popular sources for image manipulators are the raw image websites of the Mars Exploration Rovers (http://marsrover.nasa.gov/gallery/all/) and Cassini (http://saturn.jpl.nasa.gov/photos/raw/). Amateurs who follow the rovers watch for the daily downlinks and quickly stitch together the navigational panoramas to get a view on the changing landscape. Depending on the offset between Mars' and Earth's clocks on any given day, amateurs may get to the images before the science team does; Mars Exploration rover science team members have been heard to comment that they find it convenient to get their first look at the rovers' environment through the panoramas posted to unmannedspaceflight.com rather than going through the work to access the mission data servers to get the formal data. For Cassini, each close encounter with a Saturnian moon is eagerly anticipated by amateurs who stitch together high-resolution mosaics, flyby animations, or color views.

Like amateur astronomers, amateur image processors often have skills and equipment equal to professionals', and their contributions of personal time and their eye for detail have allowed them to make significant contributions to space science and exploration. The more serious amateurs dig through archives like those of the Voyagers, Vikings, and Mariners to bring modern image processing power to bear on ignored data sets. One amateur, Ted Stryk, discovered inner moons of Neptune and their shadows transiting the planet in Voyager 2's approach images and is now attempting to track down original Pioneer 10 and 11 data from Jupiter in order to compare the Pioneers' unusual polar views of the planet with the ones we'll get from Juno. Others, like Bjorn Jonsson and Daniel Machacek, are working with Voyager high-resolution mosaics that previously have not been assembled because of the challenges of changing viewing geometry and cloud motion. Amateurs have even provided input into mission planning, most notably on New Horizons. That mission requested help in identifying opportune moments during the Jupiter and Pluto flybys for "Kodak moments," pictures to be taken when alignments of multiple targets would make for especially pretty pictures. Three such imaging opportunities proposed by Richard Hendricks made it into the New Horizons Jupiter flyby sequence, resulting in some of the most popular images from that encounter.

These amateurs are an underutilized resource. For the most part, the images that they produce are not suitable for scientific interpretation, but because of their interest in producing views as the human eye might see them, their pictures have emotional power that make them terrific illustrations—and powerful advertisements for continuing the exploration of our solar system. To support this community, the Planetary Society has recently formed a partnership with unmannedspaceflight.com, and is now establishing an online repository for amateur-processed images at amateurspaceimages.com. We hope to see more and more people enjoy space exploration through the eyes of our wandering spacecraft!

This panorama of Victoria Crater as seen by the Opportunity rover was stitched by Michael Howard, with careful attention to removing the often-distracting seams between individual frames, especially in the sky. Then unmannedspaceflight.com member "Fredk" added in appropriately-scaled "mystery men" (two meters tall, at the top of the waving hand) to help viewers understand the size of the crater and the distances to its floor and far rim. I've been told that rover team members wished to produce and release a similar illustration, using an Apollo astronaut figure for scale, but that they were prevented from doing so because NASA would be accused of "doctoring" photos. It's up to the amateurs to make such helpful comparisons. Credit: NASA / JPL / Michael Howard / Fredk

Astronomy Education Policy

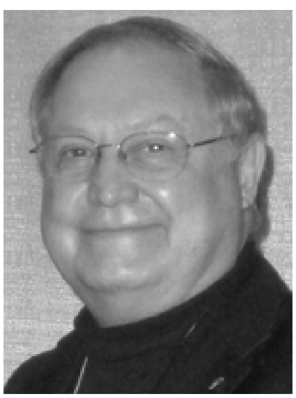
Columnist: Susana Deustua, Space Telescope Institute

In our feature article on Astronomy Education Policy we hear from Jack Hehn, Director of Education for the American Institute of Physics and AAS Astronomy Education Board Member. His article should provoke each and every one of us to "do something" to improve science education and literacy in this country. It's easy to remain uninvolved. Those of us who have children in school, or had children in school, have often discussed how poor the instruction is, how badly prepared teachers are, and what schools lack in terms of equipment. There are always exceptions, of course, and we're good at noting those. But wouldn't it be great if the exceptions were the opposite?

I do agree that it can be challenging to figure out how to get involved—we all have "day jobs" and busy lives. At the very least, we can each write our local and congressional representatives, including school boards. We all pay taxes, after all, that support K-12 education!

To PREPARE AND INSPIRE the Next Generation: An Editorial

Jack G. Hehn, Director of Education, American Institute of Physics



The Administration of President Obama has focused a great deal of attention on issues of education, and particularly, science, technology, engineering, and mathematics (STEM) education. Currently there are hundreds of efforts, public and private, underway to move the STEM reform dialogue and implementation processes forward. The next two years seem to be a critical time frame for STEM education as fundamental public values, investment, and budget decisions are under debate. Scientists are, and more should be, participating in many of these debates.

STEM education reform has seen many important influences and significant changes from the 1950's to today. An excellent synopsis of the reform cycles can be found in "Taking Science to School," a report published by the National Academies Press in 2007 (http://www.nap.edu/catalog.php?record_id=11625). That same report provides an excellent definition of science as we teach it in schools.

> "Science is both a body of knowledge that represents current understanding of natural systems and the process whereby that body of knowledge has been established and is being continually extended, refined, and revised. Both elements are essential: one cannot make progress in science without an understanding of both." (p.26)

This report also provides an eloquent narrative for why science should be taught in American schools. This work, and several other reports, from the Board on Science Education (BOSE) of the National Academy of Science provide a strong intellectual underpinning for a national dialogue based on evidence from fundamental research and practice. Unfortunately public policy does not always follow from intellectual dialogue.

In September of 2010, The President's Council of Advisors on Science and Technology (PCAST) issued a report to the President, "PREPARE AND INSPIRE: K-12 Education in Science, Technology, Engineering and Mathematics (STEM) for America's Future." (http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf) Scientists and teachers would be well served to read and review this report which characterizes itself as a "strategy for improving K-12 STEM education that responds to the tremendous challenges and historic opportunities facing the Nation." (p.iii) The report's recommendations are more

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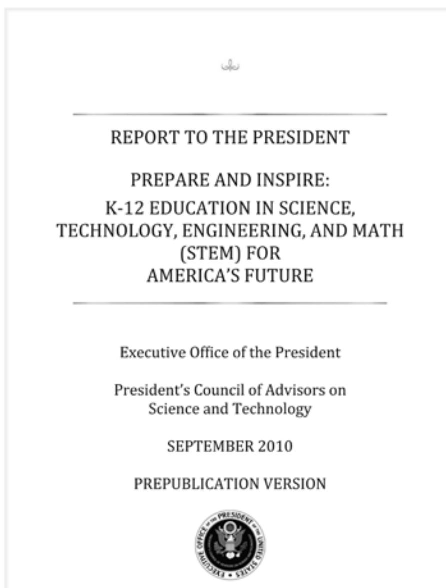
To PREPARE AND INSPIRE the Next Generation: An Editorial continued

tactical or functional in nature while the narrative expresses several ideas in rather subtle forms.

The recommendations in the report call for (1) Support for Shared Standards in Math and Science; (2) Recruit and train 100,000 great STEM teachers over the next decade who are able to prepare and inspire students; (3) Recognize and reward STEM teachers by creating a Master Teacher Corps; (4) Use technology to drive innovation (by creating an advanced Research Project Agency for Education (ARPA-Ed)); (5) Create opportunities for student inspiration outside the classroom; (6) Create new STEM-focused schools; and (7) Ensure strong and strategic national leadership (create a major collaborative effort among Federal Agencies lead by an independent Presidential Commission on STEM Education). This report is well-documented and offers an excellent bibliography in its footnotes, many referring to reports and workshops from the National Academies.

The most subtle idea might be the use of the term "inspire" to imply that our many organizational and functional efforts to improve STEM education have lacked the motivational spark that provides the desired or measurable results. Many scientists self-select into a career in science from their own sense of inquisitiveness, order, and adventure. "Inspire" brings to mind that student performance standards and high stakes testing should represent a floor and not a ceiling. Great teachers and schools motivate students in many ways. The opening sentence of the report states: "The success of the United States in the 21st century – its wealth and welfare – will depend on the ideas and skills of its population." (p.1) Public policy built on "adequate" progress alone is not sufficient to be competitive in global terms.


REPORT TO THE PRESIDENT

PREPARE AND INSPIRE:
K-12 EDUCATION IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH (STEM) FOR AMERICA'S FUTURE

Executive Office of the President

President's Council of Advisors on Science and Technology

SEPTEMBER 2010

PREPUBLICATION VERSION

While the report focuses on student performance and creating opportunities for students, it recognizes the overarching importance of teachers who create, protect, and preserve the school's learning environment and lead the learning community. The report acknowledges the need to provide inspiring opportunities for the top preforming students, as well as a content and context rich STEM environment for ALL students, including groups that are currently under-represented in STEM careers. Technology, while not held up as a panacea, is recognized for its ever-increasing influence and importance in learning environments in and beyond the classroom.

Public education in the United States is a complex enterprise primarily controlled by local interests but in increasing need of comparable student opportunity and demonstrated outcomes of achievement between different regions of the country. The report rightly recognizes the need for "alignment" among the complex elements of the educational system—the individual school environment, state and local curriculum and standards, student assessment, staff preparation and professional development, staff retention, staff reward policies and procedures, extracurricular efforts, and many other elements of the educational system that should work in unison to be effective. The report's section on assessment approaches the complexity and cost of a measurement and data system that could be used to improve student performance. This is a subject for considerable continued dialogue.

Perhaps the most significant message delivered by this report is the need for a more coordinated federal effort toward STEM education and the significance of the role of national leaders who recognize the timeliness and criticality of an effort to provide scholarly guidance in a call for broad taxpayer and corporate support and limited federal investment.

The rigorous scholarship of teaching and learning has made significant gains in the past thirty years. STEM education has changed remarkably, but there is so much improvement that needs to continue. This is a critical time for scientists to bring their voices and their experience to the public debate about the value of science and science education in America. Scientists can and should play a pivotal role in "inspiring" the next generation of STEM professionals.

You can read the full report at: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

Aligning for Learning: Strategies for Teaching Effectiveness

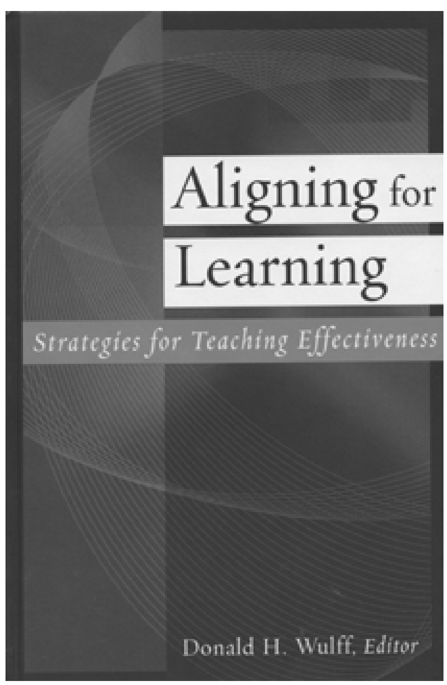
Edited by Donald H. Wulff

Anker Publishing, ISBN: 1-882982-82-7

Adam J. Burgasser, Reviewer

University of California, San Diego

Young instructors learn all manner of tools to improve their classroom teaching: clickers, Think-Pair-Share, and Lecture-Tutorials, to name a few. But we rarely encounter a philosophy with which to frame teaching choices. *Aligning for Learning: Strategies for Teaching Effectiveness* presents a well-developed and well-tested model for teaching called "the alignment model". The book provides a reference guide on how to improve teaching using the model, although it is somewhat sparse on specific strategies.



Aligning for Learning is the culmination of 20 years of research into the alignment model, with 16 articles from 18 education researchers discussing theory, applications and case studies. The late Donald H. Wulff edited the book and originally developed the model after researching best practices among highly effective instructors. In a nutshell, alignment emphasizes harmony between the needs and expectations of students, instructors and course content. For example, if an instructor expects students to use calculus in a course, while students expect to do little math, there is a clear misalignment that will cause problems. Wulff advocated for communication and engagement between students and instructor, a clear structure to the course and its requirements, and continuous assessment and adjustment to maintain alignment.

Aligning for Learning is organized into five parts. This first part, describing the alignment model, may seem impenetrably theoretical; fortunately, the rest of the book is devoted to practical applications of the alignment model in instruction. The second part of the book describes how alignment can be implemented in the design of a course. Here there is detailed discussion on questions such as "What should my students be able to do at the end of the course?" and "How do I know they are learning?" The third part of the book focuses on applications of alignment in different teaching situations, such as large courses, team teaching, and online learning. This section will likely be the most valuable for instructors because it presents alignment in action, including suggestions for implementation and detailed case studies. The fourth part of the book takes alignment beyond the realm of instruction, examining applications in education research and faculty evaluation. Wulff concluded *Aligning for Learning* by addressing common problems instructors face in implementing this model in their courses.

At just under 250 pages, *Aligning for Learning* is short enough to be read cover-to-cover. However, it is best used as a reference guide, with chapters laid out as independent studies of specific alignment applications. The book covers a breadth of topics at the expense of specific strategies for implementing the model; the focus is on concepts, rather than tools. Readers will also find some chapters more relevant than others. For Astro 101 instructors, Freisem and Coutu's contribution "Aligning in Large Class Instruction" serves up an enlightening illustration of alignment in a non-majors survey course. Coutu offers advice on how to establish rapport, emphasize organization and encourage questions. By comparison, the chapter on alignment in research and faculty evaluation seems geared specifically to education researchers and administrators. Finally, there is a broad range of readability among the chapters; most are accessible to a

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Aligning for Learning: Strategies for Teaching Effectiveness continued

non-expert educator, but a few are hopelessly buried in edu-speak jargon.

Nevertheless, I came away from *Aligning for Learning* with a deep appreciation of the framework of alignment, and many of the case studies discussed had clear analogies to my own teaching experience. Even chapters I thought would have no relevance on my instruction proved to be inspirational. Arora's examination of alignment in critical studies ("Aligning in Socially Transformative Courses") is well-written and motivates me to consider designing a critical studies course for my own department. While this would have once been well outside my comfort zone, the alignment model described in *Aligning for Learning* provides just the kind of framework a young instructor can use to expand her or his reach as an educator.

Astronomy Education Review: New Volume http://aer.aas.org

Astronomy Education Review (*AER*) is a web-based journal and is for everyone who works in astronomy and space science education. Published by the American Astronomical Society, the journal welcomes research papers related to education and outreach. All papers and articles are refereed.

AER is continually adding additional publications to its annual volume. The recent additions include:

- "Lunar Phases Planisphere": Stephen J. Shawl
- "Urban Middle-School Teachers' Beliefs about Astronomy Learner Characteristics: Implications for Curriculum": Rommel J. Miranda
- "Do Concept Inventories Actually Measure Anything?": Colin S. Wallace and Janelle M. Bailey
- "Improving Instructor Presence in an Online Introductory Astronomy Course through Video Demonstrations": Scott T. Miller and Stephen L. Redman
- "Enhancing Student Performance in an Online Introductory Astronomy Course with Video Demonstrations": Scott T. Miller and Stephen L. Redman
- "Daytime School Guided Visits to an Astronomical Observatory in Brazil": Pedro Donizete Colombo, Silvia Calbo Aroca, and Cibelle Celestino Silva et al.
- "Survey of the Goals and Beliefs of Planetarium Professionals Regarding Program Design": Kim J. Small and Julia D. Plummer
- "Call for Co-Operation in the Development of a Stack Exchange Site on Science Teacher Professional Development in Astronomy": David McKinnon and Michael Fitzgerald
- "Catching Cosmic Rays with a DSLR": Kendra Sibbernsen

Contributions to *Spark*

We encourage all members of the community to contribute articles to *Spark*, which is published twice a year to coincide with the fall and summer meetings. If you are interested in making a contribution, we recommend sending us a brief description of your proposed contribution in advance so that we can discuss your idea and suggest a suitable article length (generally around either 400 or 800 words). Our editorial meetings are held in February and August of each year, so suggestions received before those months are easiest for us to incorporate. Article deadlines are April 1 for the issue released at the summer meeting, and October 1 for the winter meeting issue.

We look forward to discussing your ideas for contributions, and to reading your articles! Email the editors: Jake Noel-Storr and Gina Brissenden at spark@aas.org.

AAS Divisions, and other, News…

Spark Columnist & AAS Astronomy Education Board Member, Ed Prather, Awarded the 2011 AAPT David Halliday & Robert Resnick Award for Excellence in Undergraduate Physics Teaching
Excerpt from the AAPT's Press Release

The AAPT David Halliday & Robert Resnick Award for Excellence in Undergraduate Physics Teaching award is given in recognition of contributions to undergraduate physics teaching and awardees are chosen for their extraordinary accomplishments in communicating the excitement of physics to their students.

When informed of his selection for this award, Prather said, "When I was an undergraduate physics major I spent countless hours pouring over my Halliday and Resnick physics textbook - it was my physics bible. It is quite an honor to be recognized, with this particular award, for something I am so passionate about—sharing my love of physics and astronomy with undergraduates, and hopefully instilling in these students just how important science is to our society and to our everyday lives."

Prather is Associate Professor, Department of Astronomy-Steward Observatory, at the University of Arizona where he serves as Executive Director of the NSF, NASA, and JPL funded Center for Astronomy Education (CAE).

Astrobites: Literature Journal & Weblog for Undergraduates
Nathan Sanders, Harvard Univ.

Do you know undergraduate students beginning research in astronomy? Point them to Astrobites, a new daily astrophysical literature journal and weblog written by graduate students at Harvard University and the University of Michigan. Each day we distil one interesting astro-ph paper into a brief format at a level accessible to undergraduate students in the physical sciences. Our goal is to develop a gateway to astrophysical research for undergraduates. Readers will learn about the latest research, major questions motivating the field, observational and theoretical techniques, and what it's like to observe at a large telescope or attend a AAS meeting.

Visit us on the web at http://astroph.wordpress.com/
Email us at astrobites@gmail.com

An Education Update from the AAS Solar Physics Division
Zoe Frank, AAS SPD E/PO Committee

There have been a few changes to the AAS Solar Physics Division Education and Public Outreach (SPD E/PO) committee over the last year. Following the joint AAS/SPD meeting in Miami in summer 2010, committee member Emilie Drobnes followed her heart to Switzerland and an opportunity to work with the European science community. We miss Emilie's exuberance and her guidance and we wish her the best. Luckily for us, Martha Wawro stood up to the challenge of assisting the committee on some of the wonderful projects that Emilie championed.

Members of the SPD E/PO committee have continued bringing the beautiful images and fun science of solar physics out to schools and public events over the last year. Martha Wawro and I have been involved in several public outreach events, including the Exploration Station event (associated with the American Geophysical Union meeting) in San Francisco; a hands-on science exhibit entitled "The Navy in Space" associated with the US Navy's Fleet Week in San Francisco; and the WeatherFest event (associated with the American Meteorological Society meeting) in Seattle. Images from the NASA Solar Dynamics Observatory (SDO) have been a joy a to work with and we've taken several opportunities to bring solar science into the home, as well as the classroom, using social networking tools. Dave Dooling was featured in a NASA EDGE segment, taking some time to explain the wonders of sunspots, and Trae Winter is busily working to incorporate new solar images into the WorldWide Telescope Program.

Our web presence is up to date thanks to committee members Ignacio Ugarte-Urra and Julie Stern. Julie has continued a superb job in gathering articles for the Coronal Courant student newsletter along with a little help from Dave McKenzie. The Courant has become a stronger publication than a simple newsletter and is a catch-all for news, announcements, interest stories, and a reports on student research in solar physics. If the readers of Spark have an interest in contributing to the Coronal Courant, please contact Julie. Ignacio has provided links to the Courant from the main EPO web site at http://spd.aas.org/navbar_edout.html along with other updates to our website.

Figure 1: Kim Coble (Chicago St. Univ.; not pictured) brought a crew of her undergraduate students to the Boston meeting so they could present their research. Pictured here are Brian Elwood, Carmelita Camarillo, Melissa Nickerson, and Virginia Hayes. **Figure 2:** This group packed the house and wowed the crowd with their Astronomy Unexpected! Innovative Strategies for Reaching Non-Traditional Students: Alan Marcher (Boston Univ.), John Mannone (Barnard Astronomical Society), Michael Francis (Stars Science Theater), Noreen Grice (Session Chair; You Can Do Astronomy, LLC), Gibor Basri (UC Berkeley), Frank Summers (STScI), and Kevin Lee (Univ. of Nebraska). **Figure 3 and 4:** Daniel Gifford (Univ. of Michigan), Nathan Sanders, and Ian Czekala (both from Harvard) seem quite happy to begin sharing their new creation, Astrobites, the astro-ph Reader's Digest—but then, maybe they were just enjoying their own Astrobite cookies a bit too much. **Figure 5:** Joseph Amato (Colgate Univ.), Karen Kwitter (Williams Col.), Charles Holbrow (Session Chair; Colgate Univ./MIT), Chris Impey (Univ. of Arizona), Philip Sadler, and David Chabonneau (Harvard) look very happy after their session on Using the Discoveries of Astronomy to Teach Physics.